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ADVANCED INTELLIGENCE INFORMATION SYSTEM (AIIS) HYPER TOOLKIT

Calspan SRL Corporation

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In this rapidly changing world, intelligence analysts analyze the latest information on foreign systems and trends and produce assessments of the present and anticipated future capabilities of particular countries. For these assessments to be of maximum utility to operational planners and national decision makers, it is necessary to:

-- reduce the time it takes to produce and disseminate intelligence products/information, and;

-- provide better and more effective ways of packaging and presenting the information to facilitate its access and understanding.

To help address these problems, this effort focused on the development of the Hyper ToolKit to provide efficient means for creating and maintaining electronic linked multimedia documents and information spaces, particularly in World Wide Web (WWW) formats (e.g., HTML), to provide fast dissemination and online viewing by the intelligence community via electronic means such as Intelink and other networks, dial-up facilities, CDROM, etc. The Hyper ToolKit includes popular "off the shelf" word processing and media editing tools to enable users to work with familiar tools; support for information organization; and automation of lower level publishing" operations via rule-based processes for automated hyperlink insertion, linked wallet-sized image generation and insertion, format conversion, special character handling, table of contents generation, header/footer generation, etc. The Hyper ToolKit has been developed under contract to Rome Laboratory for intelligence analysts at the National Air Intelligence Center (NAIC), at WPAFB OH.

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1. ABSTRACT

In this rapidly changing world, intelligence analysts must gather, review, and analyze the latest available information on foreign systems and trends to produce assessments of the present and anticipated future capabilities of particular countries. Such intelligence analyses are instrumental in establishing national intelligence estimates, aiding operational planners in developing tactics, and defining threats to support R&D for the development of new or improved weapon systems. For these intelligence products to be of maximum utility, it is necessary to:

1. Reduce the time it takes to produce and disseminate documents, and

2. Provide better and more effective ways of packaging and presenting the information to facilitate its access and understanding.

To help address these problems, Calspan is developing the Hyper(media) ToolKit to provide efficient means for creating and maintaining electronic linked multimedia documents and information spaces to provide fast dissemination and online viewing by the intelligence community via electronic means such as networks (e.g., Intelink, Internet), dial-up facilities, CDROM, etc.

The Hyper ToolKit is an easy-to-use, document-focused, integrated suite of tools that includes popular "off the shelf" tools to enable users to work with familiar word processors and other media editing tools. The ToolKit is designed to be extensible so that additional media tools and word processors can be added with ease.

The graphical user interface (GUI) provides visual iconic representations of documents, information objects, and object groups. The direct manipulation interface enables users to perform most operations via "drag and drop" or "point and click" mouse actions.

The Hyper ToolKit automates many functions so that lower level operations are transparent to the user. The user is able to "publish" an electronic hyper document or hardcopy document at the click of a button. The "publishing" process for hypermedia documents includes automatic format conversion, automatic rule-based hyperlinking, automatic rule-based Table of Contents generation, and other features. Individual hyperlinks can also be inserted by the user in a semi-automated manner using primarily point and click mouse actions.

The Hyper ToolKit increases user productivity by enabling users to focus on the organization and content of their products and not on the details of linking, formatting, and publishing.

The Hyper ToolKit provides information object management facilities that enable users to organize their information objects and documents according to hierarchical grouping schemes of their own design (e.g., by country). Using the visual ToolKit GUI, users can create groups and views "on the fly" and add/change object meta data.

The Hyper ToolKit is being developed as part of the Advanced Intelligence Information System (AIIS) Program, funded by Rome Laboratory, for intelligence analysts at the National Air Intelligence Center (NAIC) and other agencies and users. The AIIS Hyper ToolKit is being developed using staged prototyping, a sequence of builds that increase functionality, guided by user feedback on the successive builds.

2. INTRODUCTION

2.1. Identification

(1) This document is the Final Technical Report for the Advanced Intelligence Information System (AIIS) Hyper ToolKit (HTK) program.

2.2. Document Overview

(1) The purpose of this document is to report on the objectives, accomplishments, and lessons learned for the AIIS program, and to discuss the functionality and usage of the HTK (referred to as the HTK within this document) developed as part of this effort. The summary has been presented in Section 1; the introduction in Section 2; the problem definition in Section 3; the solution approach in Section 4; Hyper ToolKit features in Section 5; Hyper ToolKit advantages in Section 6; an example of Hyper ToolKit use in Section 7; future directions in Section 8; lessons learned in Section 9; a summary in Section 10; the referenced documents in Section 11; and notes in Section 12.

3. PROBLEM DEFINITION

(1) NAIC is the free world's leader in foreign aerospace, scientific, and technical intelligence. The mission of NAIC analysts is to assess foreign S&T capabilities that may have a bearing on the national security of the U.S. or its allies. To accomplish this mission, NAIC acquires foreign data and material, analyzes foreign systems, and researches and analyzes S&T development trends in foreign countries. NAIC intelligence products provide information about foreign aerospace systems, subsystems, and technologies that have military significance to the U.S. intelligence community, the USAF, and DoD organizations. NAIC products are instrumental in establishing Air Force positions in national intelligence estimates, aiding operational planners in developing tactics, and defining the threat to support R&D efforts for developing U.S. weapon systems.

(2) In addition to widening its focus to include many Rest Of World (ROW) countries, NAIC's mission has expanded in recent times to include general military intelligence (GMI) responsibilities. Thus, analysts' responsibilities have increased, their analysis problems have become more complex, and the volume of information they need to deal with has increased.

(3) Advances in worldwide electronic communications and the new networked architecture within the intelligence community and NAIC enable analysts to access increasingly voluminous amounts of information, but these facilities also burden them with the problem of managing all the potentially relevant information and documents. In fact, the quantity of information to sift through and report on has become unmanageable in many areas. Therefore, better computing tools must be brought to bear to augment the analysts' information processing capabilities.

(4) NAIC analysts and publication specialists require a computer-based work environment that will provide a well integrated suite of tools/systems to support their activities. This environment must provide high-quality online information storage and management systems; high speed information search and retrieval systems; resource management systems; network-based access to remotely located information and product databases; analysis tools; authoring/publishing systems for the preparation of traditional text-based documents and hypermedia products; and electronic network-based distribution and retrieval of intelligence products.

(5) To address the document processing dilemma, the goal of current text and hypermedia processing initiatives is to reduce the extensive amount of time an analyst now applies to the areas of information gathering and the composition, editing, and publication of intelligence products. The analyst's time must be transferred, instead, to the task of interpretation and analysis.

(6) This problem definition is based on information gathered by our team during meetings at NAIC, from documents provided to us by NAIC, and from our background and experience at NAIC and in the intelligence community. We met with numerous analysts and technical personnel to solicit their knowledge and opinions concerning relevant problems and issues. Table 3-1 lists the problems relevant to the AIIS program. Each problem is succinctly stated along with its impact on the ability of NAIC intelligence producers to fulfill the requirements of intelligence consumers. The problems are grouped into four categories:

1. Intelligence Consumers
2. Authors
3. Publishers
4. Environment

Table 3-1. Operational Problems and Impacts

1. Intelligence Consumers
1.1 Intelligence consumers cannot rapidly access relevant information. **Impact:** Customers devote more time and personnel to pour through intelligence documents and resift the information. More of both relevant and irrelevant documents must be kept at hand. Intelligence consumers are hampered in their ability to fulfill their responsibilities.
1.2 Intelligence consumers cannot readily identify and follow relevant threads through the information base. **Impact:** Consumers need navigation aids to minimize the time spent on locating and accessing relevant information.
1.3 Consumers cannot easily acquire needed information that is included as parts of larger products without acquiring the entire product, even though the other portions of the product are irrelevant to their task. **Impact:** Resources are wasted on manipulating irrelevant information.

1.4 Electronic information sharing and exchange within the intelligence community and between intelligence suppliers and consumers is severely hampered by the lack of standard "neutral" formats for information representation in the various media. **Impact:** Intelligence consumers cannot quickly and efficiently obtain needed information.
1.5 Current products provided to consumers do not incorporate different media for the best presentation of relevant information. **Impact:** Consumers spend more time digesting the included information and possibly also spend time seeking additional information that could not be included because of the lack of an appropriate media. The potential knowledge to be extracted from the intelligence will be limited.
2. Authors
2.1 The analyst workforce is being slowly downsized while analysts are being required to cover a broader scope and more areas. **Impact:** There are fewer analysts (i.e. less analyst time) covering any given intelligence objective. Precious time is spent on re-familiarization when switching between subject areas. This imposes severe time constraints on analyses. Quality of intelligence products can suffer.
2.2 There has been a significant increase in the demand for smaller products that can be produced in a short time. Analysts are having difficulty providing fast turnaround on the increasing number of products. **Impact:** Analysis and reporting for shorter products is at the expense of longer, more complete products. Severe time constraints are imposed on analyses.
2.3 Analysts don't have the tools to convey information in the best form/media to facilitate the reader/Viewer's understanding of the information. **Impact:** NAIC currently has only labor-intensive capabilities for producing hypermedia products.
2.4 Analysts are unfamiliar with the nontrivial task of authoring hypermedia products. **Impact:** Analysts will need support on the optimal communication of intelligence via hypermedia. Hypermedia authoring tools must be one source of this support. The task of authoring hypermedia products must not detract from time spent on analysis.

2.5 Support personnel are short-handed and busy, and cannot provide sufficient training and assistance to analysts. **Impact:** Computer-based tools must be easy to use and user-friendly, with good online help. Otherwise, analysts' time is spent on seeking solutions to problems and questions instead of on analysis.
2.6 There is a lack of tools that enable an author to search for information objects to be used in an intelligence product. **Impact:** Analysts spend precious time searching for information objects, rather than on analysis tasks.
2.7 Analysts do not have good tools for organizing, structuring, and relating information as part of their product preparation process. **Impact:** Analysts spend time using inefficient methods that could be better spent on analysis. The quality of products may also suffer.
2.8 There is an unutilized diversity in the types of data/information to be included in a given product and presented effectively. **Impact:** Tools must be provided to include the different data types in intelligence products and enable consumers to easily read/view the information.
2.9 Information objects need to be converted from a variety of different formats into the formats required by the product preparation tools used at NAIC. **Impact:** Without high quality converters, conversion requires manual conversion and clean-up after application of converter programs. The cost of this overhead is too high.
2.10 NAIC lacks the tools to tailor and include all the different types of media objects in intelligence products. **Impact:** Products cannot be customized and presented in the best possible form to produce focused intelligence products for targeted customers.
2.11 Intelligence authors and consumers need product meta-data (e.g., author, author's affiliation, publication date, classification, media type) and, if this data were to be unavailable, this would cause problems. **Impact:** If this data were to be unavailable, intelligence authors and consumers would not be able to perform routine activities such as contacting the author for discussion or additional information, properly handling classified information, etc.

2.12 Analysts cannot afford the time needed to handle the detailed document formats required for each product by DIA. **Impact:** Generally, the Publications group must handle these details for the analysts.
2.13 Analysts are frequently burdened with the task of producing "camera-ready" or "finished" products in order to provide their customers with needed information in a timely manner. **Impact:** Possibly lowers analysis productivity: more time spent formatting and less time spent on analysis. Too costly to do this on longer products.
2.14 There is significant diversity in the amount of experience and aptitude that different analysts have with computer-based tools. **Impact:** Computer-based tools and toolkits must provide facilities for both novice and experienced users.
3. Publishers
3.1 The increased number of shorter, urgent products are re-queued ahead of longer products in Publications. **Impact:** More time is absorbed on the overhead associated with producing short documents that consume a disproportionate amount of resources. Publication of longer products is delayed.
3.2 The Publications group cannot keep up with the volume of products. **Impact:** Analysts are demotivated to meet tight schedules. Publication backlog has grown significantly.
3.3 After the analyst delivers a draft product to the Publications group, it takes several months for scheduled products to be disseminated. **Impact:** The information in some products becomes overtaken by events and rendered obsolete by the time the product is disseminated to consumers.
3.4 The need for hypermedia production promises to compound the personnel shortage in the Publications group without much-improved tools. **Impact:** When hypermedia are involved, the current bottleneck in the IPP, particularly in the Publication group, might expand to all the authoring, fabrication and dissemination processes without high quality tools.

4. Environment
4.1 Intelink and Internet technology is rapidly evolving. **Impact**: NAIC analysts need tools that exploit these networks for information gathering and for finished intelligence dissemination.
4.2 Media technology is rapidly evolving. **Impact:** NAIC requires a hypermedia capability that is expandable and extensible so that new emerging tools can be added to the tool suite.
4.3 The ability to customize software is a feature currently used by analysts, which would become a problem if lost. **Impact:** Analysts need tools which are tailorable to their specific problem areas, work styles/methods, and immediate needs.
4.4 Analysts and product preparation specialists cannot work with numerous tools simultaneously and easily move data and results from one tool to another. **Impact:** Analysts and product preparation specialists do not receive the full benefits of having a workstation. Time is spent on overcoming the limitations of tool interoperability.
4.5 Analysts and product preparation specialists will need to perform limited tasks for which the integrated toolkit environment is not necessary. **Impact:** Analysts and product preparation specialists will need to use various tools as stand-alone tools as well as in an integrated toolkit environment.
4.6 All the tools and procedures to produce Hyper Products are not currently available in the NAIC environment. **Impact:** Process holes, disconnects and inefficiencies. Lowered productivity of analysts and publishers.
4.7 Compatibility with the Cornerstone environment and conformance with Cornerstone standards and DoDIIS standards is important, and if lacking would be a problem. **Impact:** Analysts and product preparation specialists expect and need a consistent and well integrated toolkit.

4.8 Software quality factors, such as user-friendliness and interoperability, are important and if ignored would become a problem. Other factors, such as reliability, maintainability, and extensibility, are all important for the continued usability of the hypermedia toolkit.

Impact: If tools/toolkits do not continue to be usable in the future, then valuable resources are expended on acquiring new tools and retraining personnel on the new tools.

4. SOLUTION APPROACH

4.1. Paradigm

(1) Based on an examination of the problems described in the previous section, there is a significant need to:

- Facilitate the ability of intelligence consumers to rapidly access relevant information, follow threads through the information base, and easily comprehend the presented information.
- Facilitate the ability of NAIC analysts and product preparation specialists to efficiently and quickly fabricate electronic hypermedia intelligence products and information spaces that make the best use of multiple media for conveying information in products and spaces that are focused and tailored for targeted consumers.
- Provide a hypermedia authoring/browsing toolkit that consists of a well integrated suite of tools for creating/editing media objects; managing the local media object workspace; finding and importing media objects into the workspace; and structuring, organizing, and assembling hypermedia products, pages, or information for deployment on Intelink, CD ROM, or other media
- Provide a user interface for the hypermedia toolkit that facilitates operation by users who may be either novice or experienced with regard to hypermedia authoring, computers, or data management.

(2) The AIIS HTK is being developed to help address the problems discussed in the previous section. NAIC is moving towards digital electronic means for delivering finished intelligence to better serve its customers. The Intelink and CD-ROM are becoming increasingly important as a means of delivering focused intelligence results to its customers in a more timely manner than traditional hardcopy publications.

(3) NAIC is also moving away from a reliance on traditional types of products for delivering finished intelligence to its customers, and moving towards the authoring, publication, and maintenance of "information spaces" as a potentially better way to serve its customers. Ideally, information spaces would be maintained to provide up-to-date information and analysis results on the major domain topic areas for which NAIC analysts are responsible. To the extent possible, up-to-date intelligence results would be

maintained on important domain areas, instead of intelligence results being prepared primarily in reaction to a crisis or "hot spot" situation.

(4) We define an "information space" as the body of knowledge that is comprised of a logically organized collection of information objects. Each information object is a data aggregate that forms a logical module. The object could be represented in the form of text, imagery, video, graphics, etc. or a combination thereof.

(5) Under the new AIIS paradigm, analysts' efforts are focused on maintaining a Knowledge Information Object Space (KIOS) and an Assessed Information Object Space (AIOS). The KIOS consists of the source information of interest to the analyst. The AIOS consists of finished intelligence information objects suitable for packaging and disseminating to consumers. Additionally, the analyst may wish to maintain Supplementary information objects in the Supplementary Information Object Space (SIOS). A supplementary object is one which is used in a product but is not stored as knowledge or part of the authored space. For example, specific summaries and conclusions focused to particular customers may be stored in the SIOS. The relationships between the Information Object Spaces (IOSs), the source data and the products produced is depicted in Figure 4.1-1.

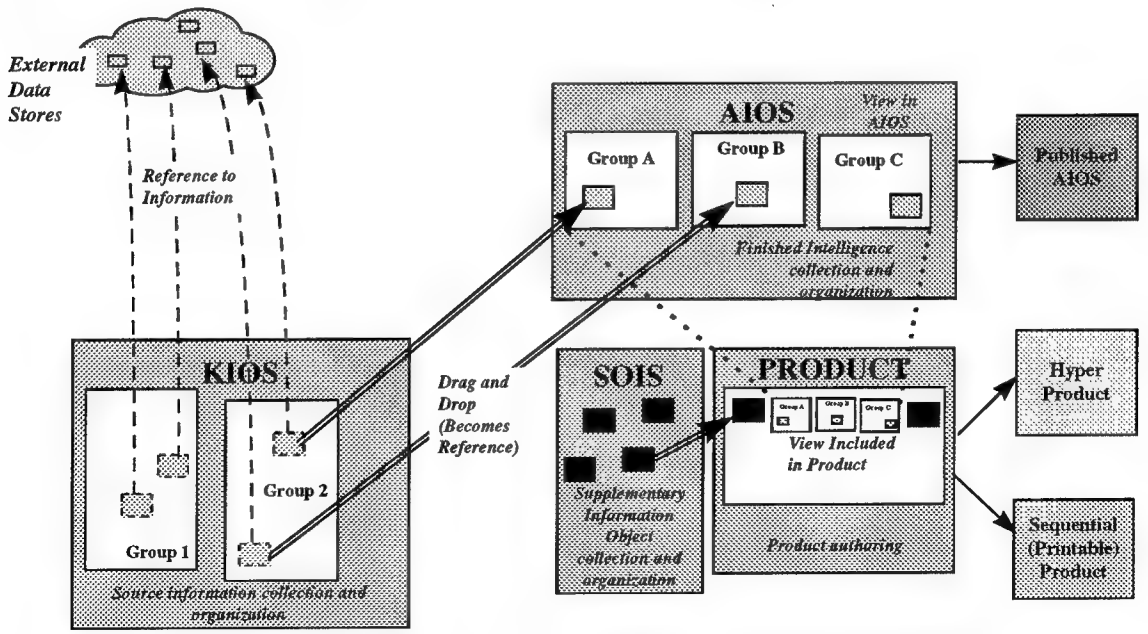

Figure 4.1-1. Relationship of AIIS Paradigm Components

(6) Organization of the KIOS is supported by the Knowledge Information Object Manager (KIOM) component of the Hyper ToolKit. Organization of the AIOS and

SIOS are supported by the Assessed Information Object Manager (AIOM). Objects in the AIOS and SIOS will be physically stored once, but may be contained in multiple product instances. Under the AIIS paradigm the authoring process becomes a matter of indicating the appropriate organization of objects from the AIOS, adding Supplementary Information Objects from the SIOS, and publishing.

(7) To support the paradigm shift several existing concepts are redefined and new concepts introduced:

- **Information Object**: Data treated as a single entity with its associated meta information.

  Previously the data of which an information object consisted needed to be stored in a single UNIX file. In the new paradigm an information object truly represents a unit of information and not a physical file. This shift is not fully implemented in the HTK developed as part of this contractual effort.

- **Supplementary Information Object**: An information object which is used in a product but is not stored in the KIOS or AIOS.

  For example, specific summaries and conclusions focused to particular customers may be stored in the SIOS. Typically, information objects in the SIOS will occur in a single Hyper Product as product-specific information, while information objects in the AIOS will occur in multiple Hyper Products as assessed intelligence.

- **Meta Information**: The attributes of an information object or a product.

  Under the AIIS paradigm to support complex IOS organization and association of multiple UNIX files with a single information object, each attribute may have a list of values associated with it. For example, an attribute "Country" may have the value list "Iraq, Iran, Kuwait" associated with it. Analysts may add meta information to an object or a product. The meta information may be viewed and used to locate and group information objects in an IOS. The HTK also uses meta information. For example, each information object is displayed with a border whose color indicates the value of its classification level attribute.

- **Information Object Space (IOS)**: A collection of information objects and the relationships between these objects.

  The AIOS, KIOS, and SIOS are all IOSs. The AIIS paradigm places the focus of an analyst's efforts on the organization of the objects in the IOSs and the specification of relationships between the objects within an IOS. An IOS may be published. The relationships specified between information objects may be represented by hyperlinks in a published IOS.

  An example IOS is depicted in Figure 4.1-2. The IOS contains four information objects and four relationships.

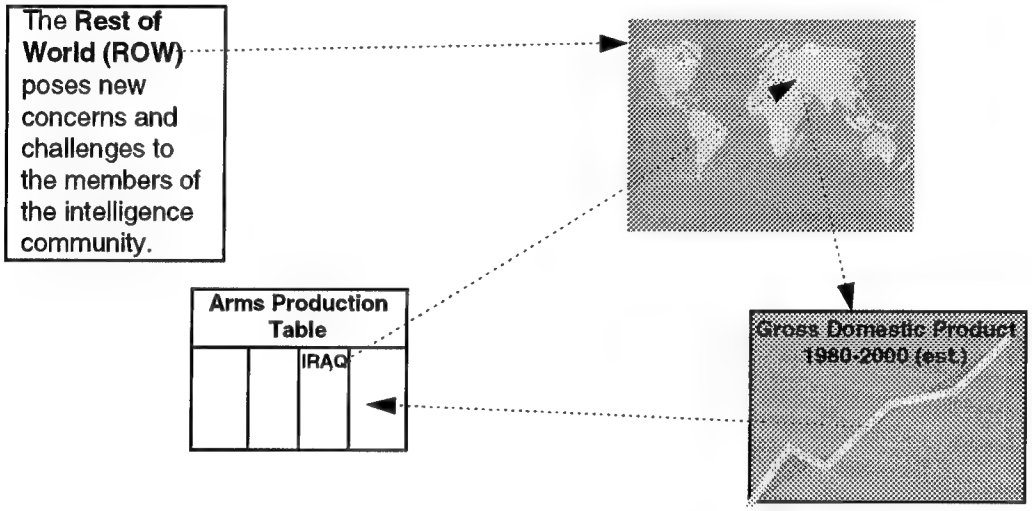

Figure 4.1-2. Information object Space

- **Knowledge Information Object Space (KIOS)**: The IOS containing all the source information of interest to the analyst.
- **Assessed Information Object Space (AIOS)**: The IOS containing a collection of finished intelligence information objects suitable for packaging and disseminating to consumers. Finished intelligence may be stored and organized in the AIOS independent of a product.
- **Supplementary Information Object Space (SIOS)**: The IOS containing a collection of Supplementary information objects.
- **Group**: A logical collection of information objects.

  Each group has an associated meta information filter (test) that can identify which objects do or do not belong to the group..

- **View**: A hierarchical collection of groups.

  When a View is included in a product, the objects associated with the View are hierarchically represented in the generated Root Information Object. A View may be displayed using a graphical icon representation or a textual list representation. When a View is applied to an IOS, the information objects in the IOS are filtered and grouped. Only the information objects which pass the test defined by the meta information filter for the group are members of the group. The members of a group are further filtered into the group's child groups.

- **Root Information Object**: The first object typically viewed in a Hyper Product or hyper published IOS.

  It provides overview information for the Hyper Product or information space. It provides entry points into the different major components of the Hyper Product or space. The HTK Hyper Publisher generates a Table of Contents (TOC) for use as a Root Information Object for a product and an alphabetical index for a space.

- **Hyper Product**: A collection of a Supplementary Information Objects, Views into the AIOS and the relationships between the objects.

  A Root Information Object is generated for each Hyper Product based on the Supplementary information objects, Assessed information objects, and Views included in the product. A Hyper Product provides an access point and a TOC for the selected view of an AIOS. When the AIOS is updated, all of the Hyper Products which refer to the information objects in the AIOS are updated.

  An example of two Hyper Products is depicted in Figure 4.1-3. Note that the hyperlinks *within* the AIOS are maintained and identical for each of the Hyper Products.

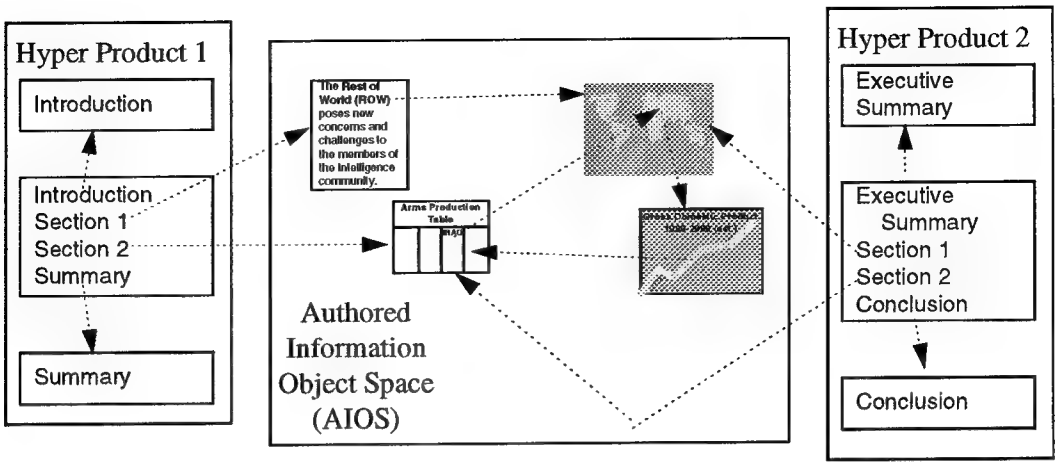

Figure 4.1-3. Example Hyper Products

Hyper Product 1 has two Supplementary Information Objects (i.e., information objects not contained in the AIOS): "Introduction" and "Summary". It also contains a View into the AIOS with two information objects: the text based object discussing the Rest of the World (ROW), and the Arms Production Table.

Hyper Product 2 has two Supplementary Information Objects: "Executive Summary" and "Conclusion". It also contains a View into the AIOS with two information objects: a map of the world, and the Arms Production Table.

4.2. Process

(1) NAIC customers are requiring shorter, more specific intelligence products which can be delivered quickly. A new process and new tools to support the process are necessary to provide NAIC customers with the needed intelligence products in a timely fashion. The AIIS Product Fabrication Process (PFP) is designed to support:

- The collection of knowledge and the maintenance of Information Object Spaces (IOSs)
- Rapid assembly of intelligence products
- Production of intelligence products which can be electronically disseminated
- Production of intelligence products which can be stored in and accessed through online repositories (e.g., Intelink)
- Production of tailored output designed for specific user needs

(2) The AIIS PFP supports the creation of both printed hardcopy and online network-based Information Spaces and Hyper Products. In the past, intelligence products

have been authored for printing. The AIIS PFP will generate products in a sequential form that provides for the generation of printable products, as well as hyper form suitable for network-based electronic viewing on Intelink via Web-browsers such as Mosaic, Netscape, or Internet Explorer.

(3) The PFP is composed of eight subprocesses: (1) Define Product Definition, (2) Manage Information Objects, (3) Create Product, (4) Publish Assessed Information Object Space, (5) Publish Hyper Product, (6) Publish Sequential (Printable) Product, (7) Access Online Help, and (8) Extend ToolKit. The PFP is illustrated in Figure 4.2-1. This is a workflow figure and the arrows represent precedence relationships. It should be noted that while the arrows in the figure represent a precedence relationship, the PFP is iterative and steps may be returned to and repeated.

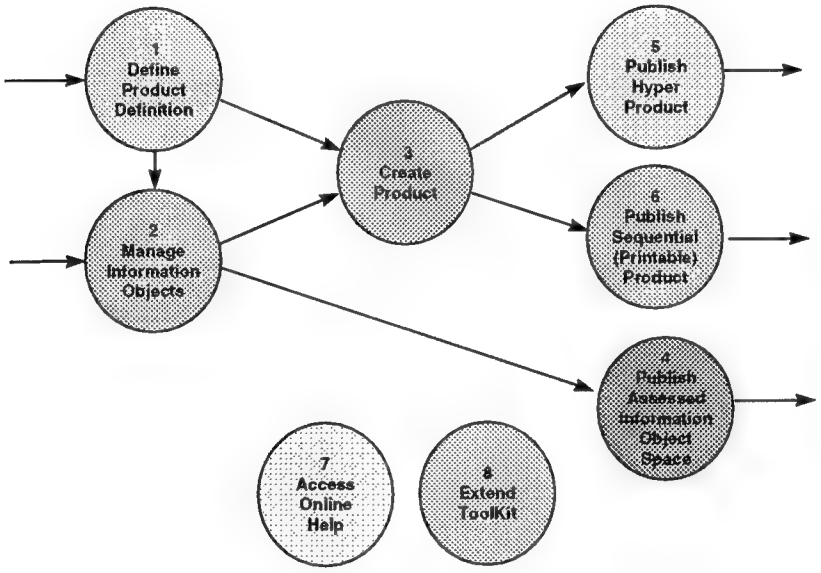

Figure 4.2-1. Product Fabrication Process

(4) Some of the processes in the PFP are in turn comprised of subprocesses. The Define Product Definition process is divided into creating and modifying product definitions, and selecting a product definition for the intelligence product being created. The Manage Information Objects process is divided into importing information objects, registering information objects, and managing information objects. The Create Product process is divided into creating and modifying information objects, manual hyperlinking, managing the product, and previewing the product being authored. The Publish AIOS process is divided into conversion to standard formats for Hyper Product generation, and

insertion of automatic hyperlinks, and packaging the product. The Publish Hyper Products process is divided into conversion to standard formats for Hyper Product generation, insertion of automatic hyperlinks, and packaging the product. The Publish Sequential Product process is divided into conversion to standard formats for Sequential Product generation and packaging the product. The concept of the PFP with these subprocesses represented is illustrated in Figure 4.2-2. This is a workflow figure and the arrows represent precedence relationships. It should be noted while the arrows in the figure represent precedence relationships, the PFP is iterative and steps may be returned to and repeated. The box enclosing the subprocesses of the Create Product process indicates that these subprocesses may be performed in any order and repeated. The gray arrow exiting the Create/Modify Product Definition Process indicates it is an optional process step. The processes and subprocesses involved in the PFP concept are discussed in the following sections.

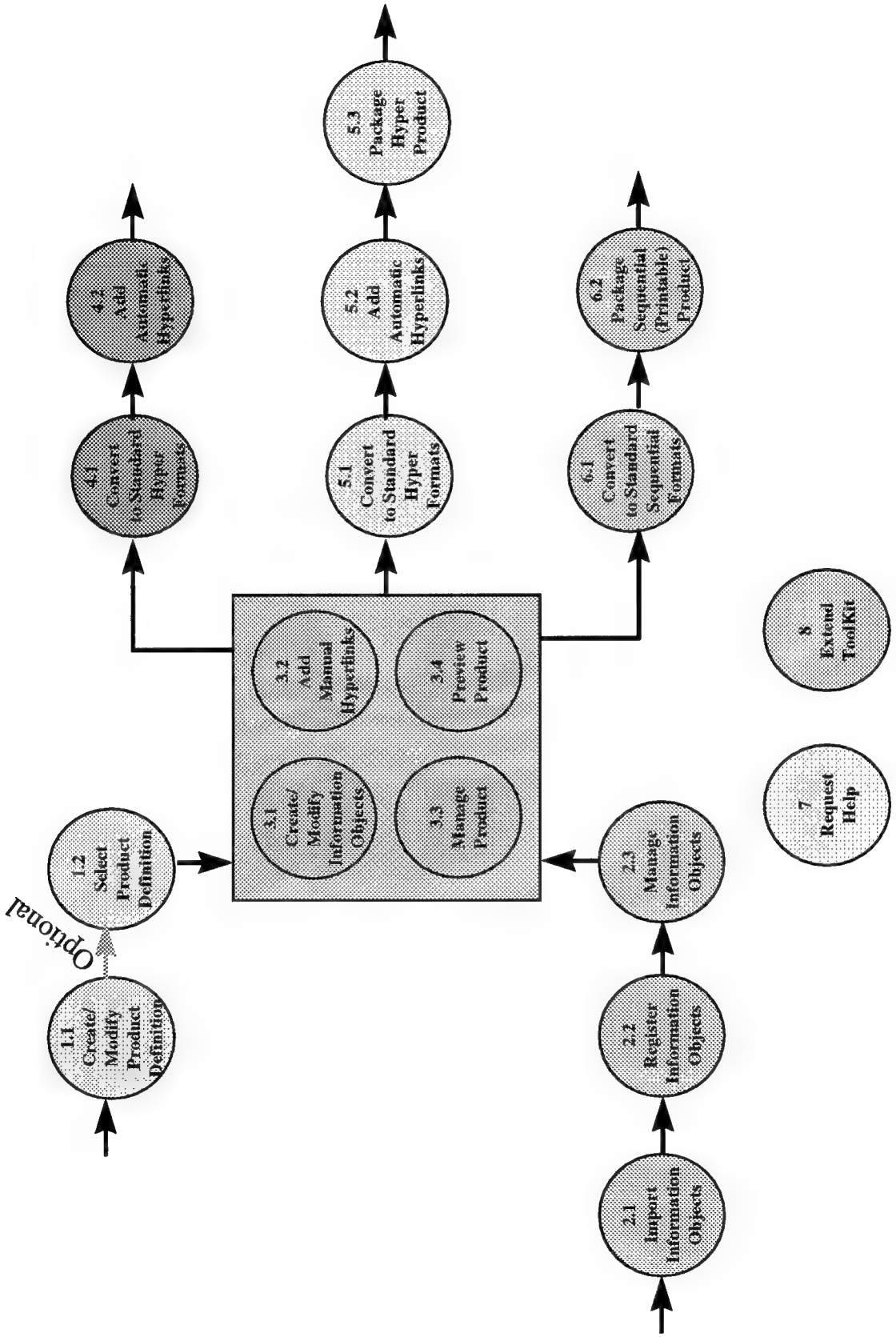

Figure 4.2-2. Process with Subprocesses

4.2.1. Product Definition Process

(1) The Define Product Definition process (Process 1 of Figure 4.1-1) involves specifying or selecting a product definition. A product definition provides information to the other steps in the process on the type of product to be produced. This information may include, for example, the outline for the product, the structure of the printable and Hyper Products, the number and type of information objects to be included in the product, and the format and fonts to be used for the printed version of the product. This process is divided into two subprocesses: (1) Create/Modify Product Definition, and (2) Select Product Definition.

(2) The Create/Modify Product Definition subprocess (Process 1.1 of Figure 4.2-2) involves the creation of new product definitions, and the modification of existing product definitions. The product definition for the product to be produced is created. If an existing product definition is similar to the one desired, it may be copied and modified to produce the desired product definition. This step of the PFP is optional. If a product definition exists for the type of product to be produced, it is unnecessary to create another.

(3) The Select Product Definition subprocess (Process 1.2 of Figure 4.2-2) involves selecting a product definition to be used for the product to be produced. Document definitions which have been created are browsed and the document definition for the product to be created is selected.

4.2.2. Manage Information Objects Process

(1) The Manage Information Objects process (Process 2 of Figure 4.2-1) involves collecting the information objects in the KIOS, authoring information objects in the AIOS, and registering these objects for use. This process is divided into three subprocesses: (1) Import Information Objects, (2) Register Information Objects, and (3) Manage Information Objects.

(2) The Import Information Objects subprocess (Process 2.1 of Figure 4.2-2) involves collecting the information objects in the KIOS. This process allows the user to browse external data sources and collect the objects which are of interest. The media type of the information objects may be any of those supported by the media tools integrated with the HTK. Both dynamic and static media types may be integrated with the HTK using the TKE. Dynamic media changes as a function of time when the analyst views it

(e.g., video clips) while static media does not change as a function of time (e.g., textual documents). Some example static and dynamic media types are shown in Table 4.2-1 (those shown in bold are currently supported by the HTK).

Table 4.2-1. HTK Media Types

Static Media Types	Dynamic Media Types
FrameMaker Text	Audio
SGML Text	Video
Microsoft Word Text	Animation
WordPerfect Text	Database Query
FrameBuilder Text	Simulation Program
ASCII Text	
IslandCalc Spreadsheets	
FrameMaker Tables	
CorelDRAW Figures	(**BOLD** items are supported
IslandDRAW Figures	supported by the ToolKit.)
FrameMaker Figures	
GIF Images	
ArcInfo/ArcView Maps	
Oilstock Maps	

(3) The Register Information Object subprocess (Process 2.2 of Figure 4.2-2) involves specifying meta-information about each information object that is imported into the KIOS. This information includes, for example, the source of the information object, the topic of the information object, media type, keywords for the information object, and the level of detail of the information object. Information objects created as part of the authoring process also needs to be registered. Each object registered must be compliant with the selected product definition.

(4) The Manage Information Objects subprocess (Process 2.3 of Figure 4.2-2) involves managing and organizing the information objects in the KIOS, authoring information objects in the AIOS based on the collected objects, and managing and organizing the AIOS. Information objects in both the KIOS and the AIOS may be organized using Views as described in Section 5.1, "Information Space Organization". Information objects created as part of the authoring process need to be registered. Each object registered must be compliant with the selected product definition. Managing and organizing the information objects includes defining groupings for the objects and specifying relationships between the objects.

4.2.3. Create Product Process

(1) The Create Product process (Process 3 of Figure 4.2-1) involves the creation and modification of information objects within a particular product, establishing author-analyst defined relationships between the selected information objects, managing the product, and previewing the product. This process is used to author discrete products as well as the AIOS. This process is divided into four subprocesses: (1) Create/Modify Information Objects, (2) Add Manual Hyperlinks, (3) Manage Product, and (4) Preview Product.

(2) The Create/Modify Information Objects subprocess (Process 3.1 of Figure 4.2-2) involves the creation and modification of information objects in the SIOS. Information objects created in the SIOS need to be registered. Each object registered must be compliant with the selected product definition.

(3) The Add Manual Hyperlinks subprocess (Process 3.2 of Figure 4.2-2) involves specifying a hyperlink between two locations within the same or different information objects. By "hyperlink" we mean a link between two locations that can be traversed at browse/view time by the reader using a browser such as Netscape Navigator or Microsoft Internet Explorer. This link type is author-analyst specified, and requires the author-analyst to indicate the source and the destination of the link. The source, destination, or both may refer to any part of the information object. For example, the source of the link may be a region of a figure, and the destination may be a paragraph in a text information object which describes the contents of the region.

(4) The Manage Product subprocess (Process 3.3 of Figure 4.2-2) involves managing the product as an aggregate. This includes operations such as starting a new product, sending a product to a reviewer or Publications, managing the product meta-information, including AIOS objects and groups of objects in the product, and including SIOS objects in the product.

(5) The View Product subprocess (Process 3.4 of Figure 4.2-2) involves viewing the printable and Hyper Products online.

4.2.4. Publish Assessed Information Object Space Process

(1) The Publish AIOS process (Process 4 of Figure 4.2-1) involves the publishing of the AIOS. This process is divided into three subprocesses (1) Convert to Standard Hyper Formats, (2) Add Automatic Hyperlinks, and (3) TOC generation.

(2) The Convert to Standard Hyper Formats subprocess (Process 4.1 of Figure 4.2-2) involves converting the information objects in the AIOS into the standard formats for Hyper Products. Standard format is important for electronically distributed products. A standard format limits the demands on a product browser, and simplifies the completion of the remaining processes.

(3) The Add Automatic Hyperlinks subprocess (Process 4.2 of Figure 4.2-2) involves adding hyperlinks to the AIOS based on the AIOS's content. Automatic hyperlink generation for the AIOS is accomplished through both user-defined and default rules and is based on the syntactic elements (e.g., words and phrases) that appear in the information objects in the AIOS.

(4) A title page and Table of Contents (TOC) are generated for each product which contains hyperlinks to each information object that was published

4.2.5. Publish Hyper Product Process

(1) The Publish Hyper Product process (Process 5 of Figure 4.2-1) involves the final packaging of the Hyper Product: (1) Convert to Standard Hyper Formats, (2) Add Automatic Hyperlinks, and (3) Package Hyper Product.

(2) The Convert to Standard Hyper Formats subprocess (Process 5.1 of Figure 4.2-2) is identical to the Process 4.1.

(3) The Add Automatic Hyperlinks subprocess (Process 5.2 of Figure 4.2-2) adds hyperlinks to the product based on the product's content and structure. As in the case of manually inserted hyperlinks, by "hyperlink" we mean a link between two locations that can be traversed at browse/view time by the reader using a browser such as Netscape Navigator or Microsoft Internet Explorer. Automatic hyperlink generation for the product is a rule-based process which operates on the product's structure and syntactic elements (e.g., words and phrases). Default rules are provided and may be augmented or changed by the user. This is similar to subprocess 4.2, except in the context of a product

the structure is also considered when adding links. These links are in addition to the ones manually generated in the Add Manual Hyperlinks process.

(4) The Package Hyper Product subprocess (Process 5.3 of Figure 4.2-2) involves producing a Root Information Object, adding headers and footers to the product, creating a title page for the product. The Root Information Object is typically the first object viewed in the intelligence product. It provides overview information for the product. It provides entry points into the different major components of the product.

4.2.6. Publish Sequential Product

(1) The Publish Sequential Product process (Process 6 of Figure 4.2-1) involves the packaging of the Sequential Product for final editing and printing. The information objects in the product are converted to a printable format (e.g., FrameMaker format) and ordered. The Sequential Product may require some manual editing to produce the final printable product. This process is divided into two subprocesses: (1) Convert to Standard Sequential Formats, and (2) Package Sequential Product.

(2) The Convert to Standard Sequential Formats subprocess (Process 6.1 of Figure 4.2-2) involves converting the information objects included in the product into standard formats for Sequential Products.

(3) The Package Sequential Product subprocess (Process 6.2 of Figure 4.2-2) involves ordering and collecting the objects in the product once converted to standard sequential formats.

4.2.7. Request Help Process

(1) The Request Help process (Process 6 of Figure 4.2-1) involves requesting help about the process, the tools used to complete the process, or the authoring of products.

4.2.8. Extend ToolKit Process

(1) The Extend ToolKit process (Process 8 of Figure 4.2-1) involves extending the HTK to support additional media types, additional external datastores, or additional sequential or hyper publishing formats.

4.3. Tools

(1) The HTK capabilities support the efficient execution of the PFP. Some of the steps are fully automated, others are supported by tools in the HTK. The HTK is integrated with unprocessed data sources (e.g., message traffic, and image files) and, in the future, will be integrated with available search and analysis tools such as DCARS, InfoDominator, and Pathfinder. The HTK contains an extensible suite of converters to translate various media types from various data sources into a format suitable for online viewing on Intelink, printing, and CD-ROM distribution. The HTK interface concept is depicted in Figure 4.3-1.

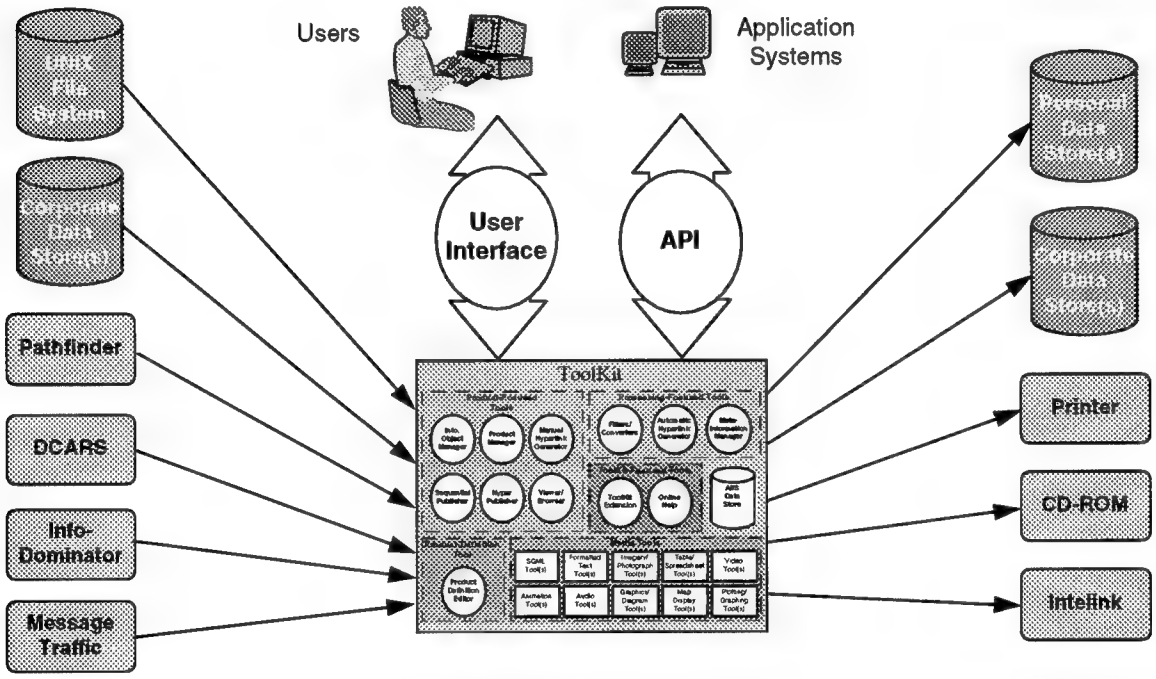

Figure 4.3-1. AIIS System Interface Concept

(2) The HTK is a loosely coupled suite of fourteen components divided into five functional groupings:

ToolKit Interfaces
- User Interface (UI)
- Application Programmer Interface (API)

Product-Focused Tools
- Information Object Manager (IOM)
- Product Manager (PM)
- Manual Hyperlink Generator (MHG)
- Sequential Publisher (SP)
- Hyper Publisher (HP)
- Viewer/Browser (VB)

ToolKit-Focused Tools
- Online Help (OH)
- ToolKit Extension (TKE)

Product Definition Tool
- Product Definition Editor (PDE)

Processing-Focused Tools
- Filters and Converters (FC)
- Automatic Hyperlink Generator (AHG)
- Meta-Information Manager (MIM)

The HTK also utilizes a local datastore (DS) and an extensible suite of associated media tools. The AIIS system concept is illustrated in Figure 4.3-2. Each of the HTK components is described in the following sections. The mapping between the processes of the PFP and the AIIS components is shown in Table 4.3-1.

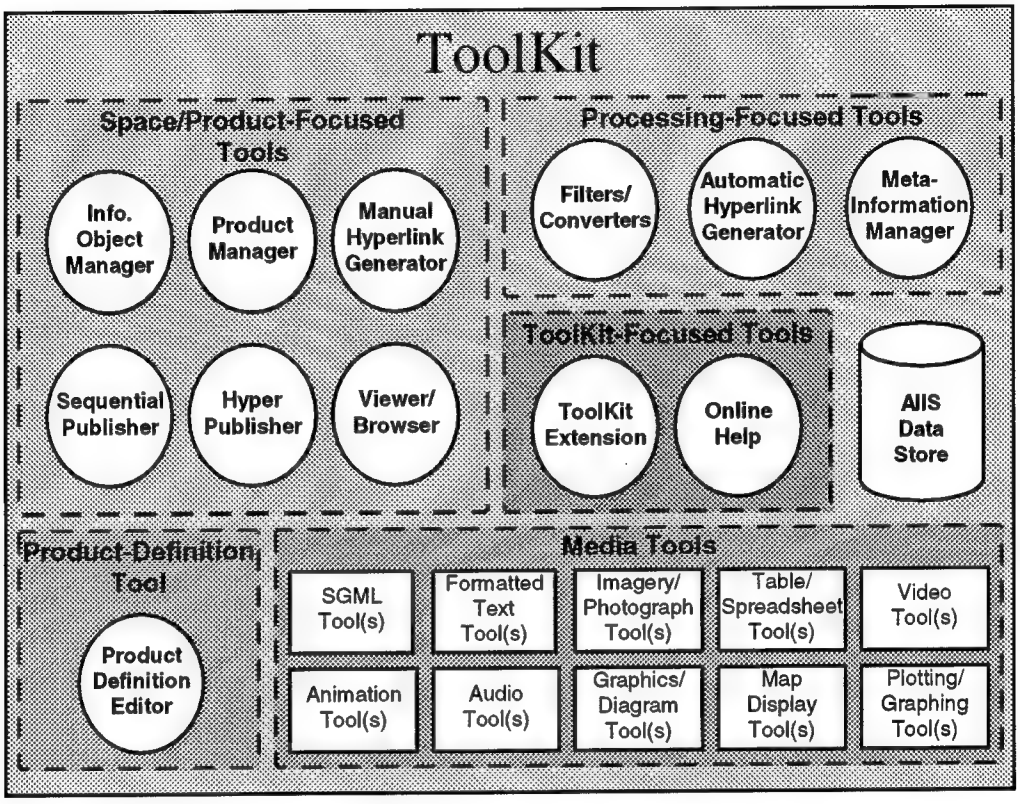

Figure 4.3-2. AIIS System Concept

Table 4.3-1. Mapping from Product Fabrication Processes to AIIS Capabilities

Number	Process	Capability	PUI
1.1	Create/Modify Product Definition	Product Definition Editor	PDE
1.2	Select Product Definition	Product Manager	PM
2.1	Import Information Object	Information Object Manager Product Manager Meta-Information Manager	IOM PM MIM
2.2	Register Information Object	Information Object Manager Product Manager Meta-Information Manager	IOM PM MIM
2.3	Manage Information Object	Information Object Manager Product Manager Meta-Information Manager	IOM PM MIM
3.1	Create/Modify Information Object	Information Object Manager Product Manager Meta-Information Manager	IOM PM MIM
3.2	Add Manual Hyperlinks	Manual Hyperlink Generator	MHG
3.3	Manage Product	Product Manager Meta-Information Manager	PM MIM
3.4	View Product	Viewer/Browser	VB
4.1	Convert to Standard Hyper Format	Filters and Converters	FC
4.2	Add Automatic Hyperlinks	Automatic Hyperlink Generator	AHG
5.1	Convert to Standard Hyper Format	Filters and Converters	FC
5.2	Add Automatic Hyperlinks	Automatic Hyperlink Generator	AHG
5.3	Package Hyper Product	Hyper Publisher	HP
6.1	Convert to Standard Sequential Format	Filters and Converters	FC
6.2	Package Sequential Product	Sequential Publisher	SP
7	Request Help	Online Help	OH
8	Extend ToolKit	ToolKit Extension	TKE

4.3.1. The AIIS ToolKit Interfaces

(1) The User Interface (UI) enables the user to access the HTK tools, the associated media editors, and other systems which support the PFP.

(2) The Application Programmer Interface (API) enables application developers to access the HTK tools.

4.3.2. The AIIS ToolKit-Focused Tools

(1) The Online Help (OH) provides context-sensitive help. Information is provided on the available software tools and the capabilities of each tool. Assistance is also provided on the overall process of product preparation. Guidance is also provided on authoring NAIC intelligence products and creating Hyper Products. This guidance includes information such as the suggested length of the product being authored, the

optional length for a text-based information object, and assistance on the number and types of hyperlinks to include in information objects.

(2) The ToolKit Extension (TKE) Tool provides assistance in extending and configuring the HTK. This enables the user to perform such operations as adding or changing media editors, adding or changing interfaces to other systems which support the PFP, and changing the system defaults to customize the look and feel of the user interface.

4.3.3. The Space/Product-Focused Tools

(1) The Information Object Manager (IOM) provides assistance in locating, copying, and registering information objects of interest. Registration is required to provide intelligence consumers and authors with product meta-information (attributes). This information is also used as input to other capabilities. The IOM manages the KIOS.

(2) The Product Manager (PM) enables the user to retrieve information on products, manipulate products, author information objects and supplemental information objects, and maintain the SIOS and the AIOS. It is able to produce a list of products being authored, start a new product, open an existing product, save changes to a product, and maintain the product information meta-data.

(3) The Manual Hyperlink Generator (MHG) allows the user to specify a hyperlink between two locations within the same or different information objects. The source, destination, or both may refer to any part of the information object. The hyperlinks are traversed by a browser such as Netscape Navigator when the reader clicks on the source text for a hyperlink when browsing/viewing a product or information space.

(4) The Sequential Publisher (SP) translated the source material into a single format and produce a Sequential Product suitable for printing.

(5) The Hyper Publisher (HP) provides for automatically translating the objects of a product or IOS into formats suitable for online viewing via the Filters and Converters. The Hyper Publisher also runs the Automatic Hyperlink Generator (AHG) on the product or IOS.

(6) The Viewer/Browser (VB) allows the user to view the hyper published objects in final electronic form. This capability is used by author/analysts during product

fabrication and AIOS management, and may also be used by NAIC customers when a product is delivered.

4.3.4. The AIIS Product Definition Tool

(1) The Product Definition Editor (PDE) is used to create and modify product definitions which define the products' structure and style. A product definition includes, for example, the outline for the product, the structure of the sequential and Hyper Products, the number and type of information objects to be included in the product, and the format and fonts to be used for the printed version of the product.

4.3.5. The Processing-Focused Tools

(1) The Filters and Converters (FC) provide for automatic conversion between various formats and the accepted neutral formats for the sequential and Hyper Products. For text, for example, the FC provides for conversion from the proprietary FrameMaker text format to SGML/HTML, and for graphics, the FC provides for conversion from the FrameMaker embedded image format to GIF.

(2) The Automatic Hyperlink Generator (AHG) automatically generates hyperlinks within the product and AIOS. Two types of automatic hyperlinks may be generated for products:

- string links - hyperlinks from a particular string (e.g., "Figure", "AIOS", etc.) to an information object (e.g., a graphical image) or a location within an information object (e.g., the manual section describing the AIOS).

- structure links - hyperlinks determined by the structural elements of a product or a space, such as headings. These would typically insert links to the next and previous structural elements of the same type.

Insertion of hyperlinks for both types is based on an algorithm which uses the product content and structure as well as a rule set. Only string links are generated for the AIOS.

(3) The Meta-Information Manager (MIM) provides the common meta information management functionality required by the PM and the IOM.

4.3.6. The AIIS Hyper ToolKit Datastore

(1) The Datastore (DS) is the local work space for AIIS Hyper ToolKit authoring and fabrication. It is useful in segregating the HTK from the voluminous intelligence databases by providing a single location for authors to store the information objects which will be incorporated into their products or information spaces.

4.4. Assistance and Training

(1) The HTK has been designed to provide an intuitive interface to developing, maintaining, and authoring based on IOSs. Nevertheless, assistance and training will be required to explain the new paradigm, educate users in the use of the HTK, and encourage the cultural shift required to accomplish full acceptance of the new paradigm.

5. HYPER TOOLKIT FEATURES

5.1 Information Space Organization

(1) The KIOM and AIOM are used by analysts to collect and organize information objects in the Knowledge and Assessed Information Object Spaces, respectively. The KIOM is used to organize source information that is of interest to the analyst, typically on a long-term basis, while the AIOM is used to organize finished intelligence.

(2) Objects in the Information Object Spaces have Meta Information, consisting of a set of attribute-value pairs such as "Country" = "China, Iran, Kuwait" where the attribute is "Country" and the values are "China, Iran, Kuwait", or "Class" = "Fighter" where the attribute is "Class" and the value is "Fighter". These objects may be organized by creating Views using a list of Meta Information attribute-value criteria. A *View* can be thought of as a filter that is applied to the information objects of a space and a *View Instance* is a hierarchically structured set of information objects resulting from the application of a View to the information objects of a space. The basic building blocks of both Views and View Instances are *groups*. A group has an attribute-value pair associated with it and filters information objects by comparing its attribute-value pair with that of the object. If an object's Meta Information contains the same attribute and any value matches the value of the group, that object will be filtered into the group. The Meta-Information Manager (MIM) keeps a list of unique attributes for each IOS and also a list of unique values that are associated with each attribute. Figure 5.1-1 provides an example.

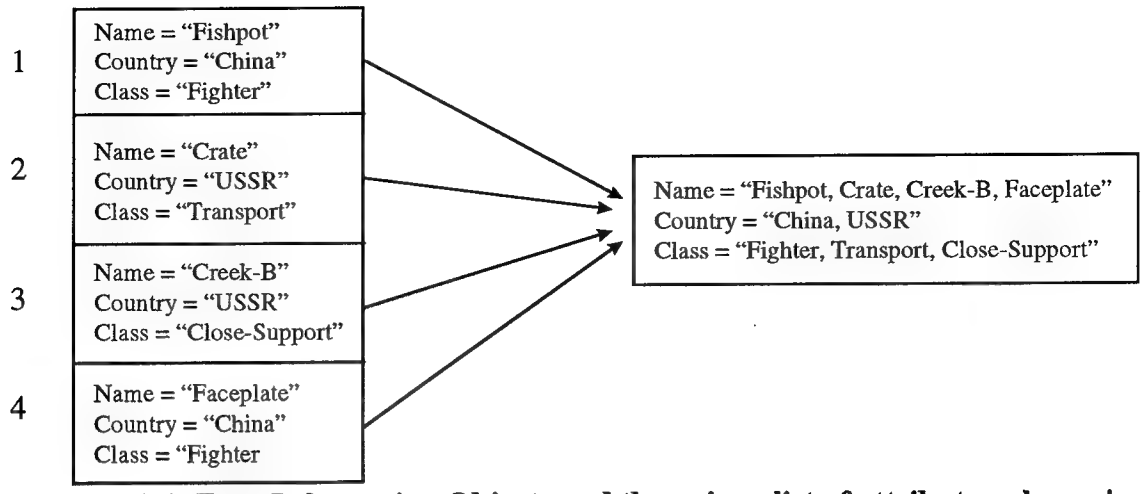

Figure 5.1-1: Four Information Objects and the unique list of attribute-value pairs stored by the MIM.

(3) When creating a View, the analyst is presented with the list of unique attributes for a particular IOS and selects a proper subset of those attributes, creating an ordered list. The MIM would then create a View consisting one "level" for each attribute selected. Assume level 0 is the root of the View, the analyst selected *A* attributes, and there were *V* unique values associated with each attribute. Level 1 will have *A* groups (one for each attribute), level 2 would have *AxV* groups (*V* groups under each group in level 1), and so on. Figure 5.1-2 illustrates this concept.

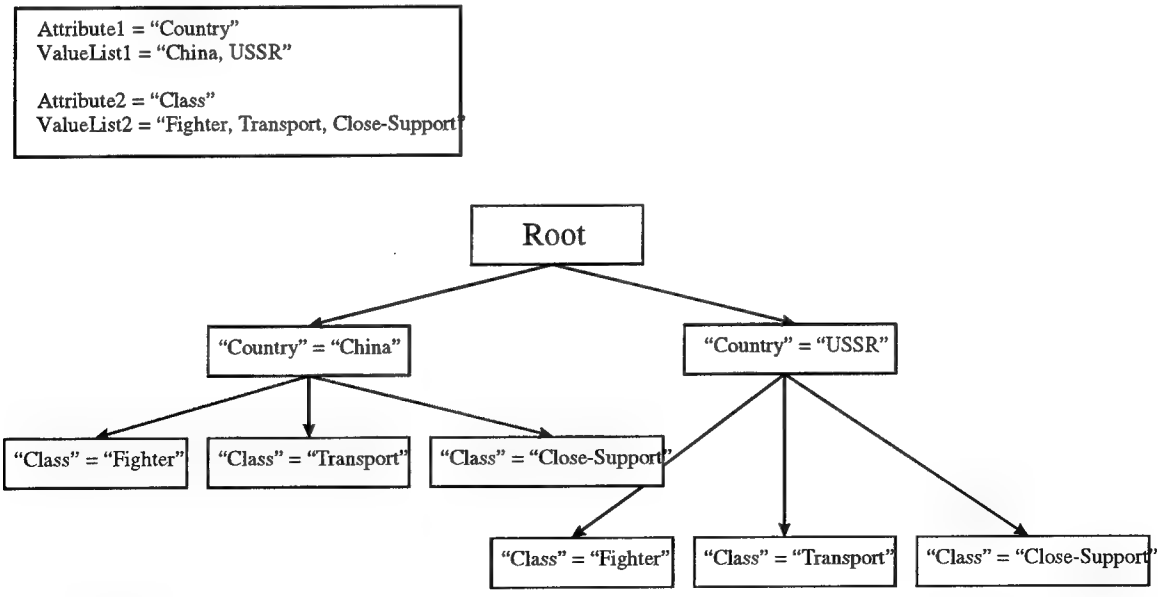

Figure 5.1-2: A View created using "Country" and "Class" attributes.

(4) The creation of a View Instance applies a View to the current contents of an IOS. Information objects are filtered from the root group through each level of the View using their Meta Information and the attribute-value pairs which make up the information objects. Filtering is accomplished by comparing the attribute-value pair for a group in a View with the attribute-value pairs in an object. If there is a match, the object is included in that group. This process is repeated for any sub-groups until there are no matches, in which case the object remains in the last group whose filter accepted it. Figure 5.1-3 shows the result of the application of the View in Figure 5.1-2 to the information objects of Figure 5.1-1 to create a View Instance.

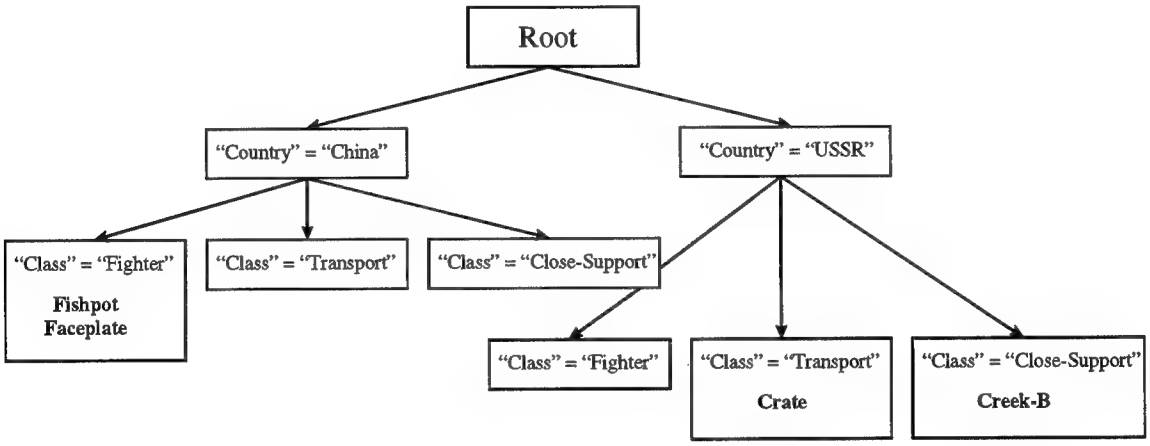

Figure 5.1-3: Example View Instance.

(5) There are four ways in which a View Instance is displayed in the KIOM and AIOM of the HTK graphical user interface (GUI). These include:

- **List** - uses folder icons to represent groups and colored icons to represent objects, as well as the group and object labels
- **Labels** - displays the view instance showing only the label for each information object
- **Icons** - displays the view instance showing only the icon for each information object
- **Both** - displays the view instance showing both the label and icon for each information object

(6) Meta Information may also be added to an object manually. After adding Meta Information to an object, the analyst can "refresh" the View Instances displayed in the IOM and the objects will be re-tested for membership in the various groups.

(7) The analyst may move an object between groups (using drag & drop via the GUI) or copy an object into a group. When an object is moved (removed from one group and added to another), the Meta Information relevant to its inclusion in the source group is automatically removed, and the Meta Information necessary for the filter to accept the object into the destination group is automatically added. Copying an object is similar, except Meta Information is not deleted and the result is the *union* of the Meta Information necessary to filter the object into *both* groups.

(8) The AIIS HTK provides an attribute type called a *reference* that enables the user to specify one-to-many relationships between the objects in a space. The analyst may create *references* from one object (called the *referencing* object) to one or more objects (called *referenced* objects) by specifying that a particular attribute is a reference at creation time, or by editing the properties of that attribute at a later date. The values associated with a reference attribute are interpreted as the names of other information objects. For example, a reference attribute named "Manufactures" for an object with "Name" = "China" might contain the values "Creek-B, Fox, Crate" indicating that "China" manufactures the objects with the names "Creek-B", "Fox", and "Crate".

(9) Reference attributes may be either included or excluded and shown or not shown for a particular View (and, therefore any View Instances created using that View). Including a reference means that any *referenced* objects will be filtered along with their *referencing* object and will appear in the View Instance along with the *referencing* object, regardless of their Meta Information. If a reference is to be shown, then color-coded arrows (whose color is specified by the reference properties) are drawn from the *referencing* object to any *referenced* objects.

5.2 Assessed Information Object Space Publishing

(1) Publishing an AIOS involves primarily two steps: (i) converting objects to standard hyper formats, and (ii) adding automatic hyperlinks. After publication, the IOS will be viewable as an HTML document in the Visual Browser.

(2) Converting objects to standard hyper formats is important for electronically distributed intelligence. The standard formats limit the demands on a viewer/browser and simplify the completion of the remaining processes. The conversion process is accomplished by utilizing the Application Programmers Interface (API) provided by the various media editors. Through the API an object is saved to a standard format, namely SGML. The SGML is then converted to HTML. Special characters (e.g., Greek characters) and equations are converted to GIF images and included in the published information objects. Graphical images are converted to wallet-sized images and are included in the published objects. These wallet-sized images are links to the original images.

(3) Hyperlinks are automatically added to each document according to the string rules that have been specified for the AIOS. Any manual links that have been specified are also included. The object is then passed through the Automatic Hyperlink Generator (AHG) to add hyperlinks for any strings specified in the ahg.rules file (typically, "figure", "Figure", "table", "Table", etc.).

5.3 Product Authoring

(1) The analyst will typically author a product, after collecting and analyzing information, at the request of a customer. Authoring a product involves creating a new product, providing a name for the product, providing product Meta Information, adding information objects from the AIOS and SIOS and also Views from the AIOS, sequencing the items in the product as desired, specifying string links (if desired), specifying manual hyper links (if desired), and publishing. The product is stored by the MIM as a list of objects and Views, along with the product name and Meta Information.

(2) Upon opening a new product, it is desirable to provide a name for the product immediately. When a product is created it is stored in the MIM under the name "New Product". If a second product is created before the first is renamed there will be two products with the name "New Product". The information in the second product will be lost due to the fact that the MIM searches for a product by name and returns the first product which matches the name, thus never finding a second product under the same name.

(3) Product Meta Information is used during the creation of the cover page and headers and footers included in a hyper-published product. Typical information includes the name of the document, classification, authors, and document type.

(4) The analyst may populate a product with information objects from the AIOS and SIOS, and Views from the AIOS. Objects may also be imported from a separate datastore or created. Importing and creating new object is accomplished through menu selections and toolbar buttons. In order to add an object from the AIOS or SIOS, the analyst would simply drag the object into the product. Currently, this operation may be performed in any View (i.e., "label", "icon", or "both") with the exception of the "list" View. A View, may be added to a product by dragging the textual label into the product. Part of a View may be added by dragging the label for a particular group into the product. The result will be the addition of a "View fragment" with the selected group and any subgroups added to the product. When a View is added to a product, it is not applied until the product is published. This ensures that, if the IOS changes between the time that the View was added to the product and the time of publication, this change will be reflected in the published product.

(5) The analyst has the option of reordering the elements in a product. This is accomplished by dragging a product element onto the element which it is to be placed *after* in the Product View (only the "labels", "icons", or "both" Views). The MIM will reorder the list of elements in the product accordingly and the display will be updated.

(6) String links are used during hyper-publication and are a method of specifying that a particular string should automatically be linked to an object. For example, it may be useful to link the word "Iraq" to a map of the country Iraq. String links are specified using the String Link Editor (SLE) in the AIOM. The analyst may select to ignore the case of the string and also whether or not the link should be to the actual destination object itself, or to a location within the destination object. When finished, an entry is created in the string rules file which is parsed by the stringLink program during publication.

(7) The analyst may include manual hyper links to be used during hyper-publication. Manual hyper links explicitly specify that a particular string in a particular object should link to another object or location within another object. Installing a manual hyper link also creates an entry in the string rules file.

5.4 Product Publishing

(1) There are two types of publication: hyper (or "electronic") publication and sequential publication. Hyper publication produces a digital document that is suitable for dissemination on Intelink and the World Wide Web while sequential publication produces a digital document that is suitable for printing on paper.

(2) The AIIS HTK performs hyper publication via four primary steps: (1) determine which files have changed since the last publication, (2) convert information objects to standard formats, (3) create automatic hyperlinks, and (4) package the Hyper Product. Each step is described in detail below.

(3) To check for files that have changed since the last publication, the operating system time stamp on the published product files are checked against the time stamp on the source files for the information objects. If no published files exist, the information object is re-published. Otherwise, they are only published if the information object files are newer (or have been modified more recently).

(4) Converting the information objects is accomplished in the same manner as described in Section 5.2, Assessed Information Object Space Publishing.

(5) Hyperlinks are automatically added to the product based on its content, structure, and syntactic elements (e.g., words and phrases). This is accomplished through the AHG. The AHG uses a rules file (ahg.rules) to determine which structures need to be automatically hyperlinked. Special characters (e.g., Greek characters) and equations are converted to GIF images and included in the published product. Graphical images are converted to wallet-sized images and are included in the published product. These wallet-sized images are linked to the original images.

(6) A published Hyper Product is packaged by generating a Root Information Object, adding headers and footers to the product, and creating a title page. The Root Information Object is typically the first object viewed in the intelligence product. The contents of the root object are created using the <H*n*> SGML tags where *n* is currently 1, 2, 3, 4, 5, or 6. The content of these headers is used as the source of a hyperlink and the header in the document itself is used as the destination (i.e., if "1. System Overview" is a 1st level header in an object, then "System Overview" in the root object would be a hyperlink to the actual information object. Headers and footers provide a link to the table of contents and links to the next and previous information objects. The document

classification is also displayed in the header and footer. The title page is created using product Meta Information and displays information including the document type, the title of the document, the authors, and the classification.

(7) Sequential publication of a product involves two steps: (1) conversion of information objects to standard formats, and (2) packaging the product.

(8) Converting the information objects is accomplished in the same manner as described in Section 5.2, Assessed Information Object Space Publishing.

(9) Packaging a Sequential Product involves collecting the individual objects, ordering them according to the sequence that was specified by the user during product creation, and converting to a printable format (e.g., FrameMaker). Sequential Products may require some manual editing to produce a final printable product.

6. HYPER TOOLKIT ADVANTAGES

(1) There are several advantages that the AIIS HTK offers over other hyper-authoring tools that are currently available on the market.

(2) The AIIS HTK provides facilities that allow the analyst to organize information as well as facilities for creating documents that are suitable for dissemination via the World Wide Web. Most products on the market do not provide the capability for information organization, but simply a method to export a document in a format suitable for electronic media (e.g., HTML or SGML).

(3) The AIIS HTK allows the analyst to specify rules for two types of hyperlinks. These rules are used to automatically create hyperlinks in electronically published documents. The two types of automatic hyperlinks are:

- string links - hyperlinks from a particular string (e.g., "Figure X", "AIOS", etc.) to an information object (e.g., a graphical image) or a location within an information object (e.g., the user manual section describing the AIOS).

- structure links - hyperlinks determined by the structural elements of a product or a space, such as headings. These would, for example, insert links to the next and previous structural elements of the same type.

(4) Information objects are stored in their original (native) format and are only converted to standard formats (e.g., SGML) when the analyst opts to publish a product or IOS. The information objects may be viewed in their native editor (i.e., the media editor that was used to create them, such as FrameMaker, CorelDraw, etc.) at any time.

(5) The AIIS HTK allows click-of-a-button publishing, thus allowing analysts to spend their time on information discovery and analysis instead of on the details of publication. With a single button click, information objects are converted to standard electronic formats (i.e., SGML, GIF, etc.), hyperlinks controlled through user-defined and default rules are automatically added to the information space or product based its content, structure, and syntactic elements (e.g., words and phrases), special characters (e.g., Greek characters) and equations are converted to GIF images and included in the published product. Graphical images are converted to wallet-sized images and are included in the published product. These wallet-sized images are links to the original

images. A title page and Table of Contents for the product is generated and headers and footers are added to each object to assist the analyst in navigating the product by providing next and previous links.

(6) The AIIS HTK has integrated organizational tools and publishing tools together into a single toolkit. This allows the analyst to become familiar with a single interface rather than learn to use several products and switch between them to perform different tasks.

(7) Information objects, once imported into a space, may be reused in multiple Views and products. This saves the analyst the effort involved with entering the information multiple times. Information objects may be:

- Edited by double-clicking on the object
- Organized into hierarchical groups (View Instances) by filtering on their meta information attributes.
- Moved and copied between groups
- Published as an entire space
- Imported into products

7. DETAILS OF HYPER TOOLKIT USE

7.1. Concept

(1) The HTK concept may be viewed logically. This view shows how the tools in the HTK support the PFP. The KIOM supports the Manage Information Object step of the process (Step 2 in Figure 4.1-1). The AIOM portion supports the Create Product (Step 3 in Figure 4.1-1), Publish AIOS (Step 4 in Figure 4.1-1), Publish Hyper Product (Step 5 in Figure 4.1-1), and Publish Sequential Product (Step 6 in Figure 4.1-1) steps of the process. The logical concept of the ToolKit is depicted in Figure 7.1-1. The logical view has three Information Object Spaces: the KIOS, AIOS, and SIOS. The KIOS is comprised exclusively of references to information objects (represented by dashed lines and dashed boxes in Figure 7.1-1). An information object may be dragged from the KIOS and dropped onto an object in the AIOS (represented by a double lined arrow in Figure 7.1-1). The object from the KIOS is then associated with the object from the AIOS as reference or source material. New objects may be created in the AIOS to hold new assessments of information from the KIOS. The AIOS may be organized using Views. A View may be included in a product. The AIOS may be Hyper Published. New objects may be created in the SIOS to hold new supplementary information. An object may be dragged from the SIOS and dropped into a product. The objects and Views of a product may be sequenced using drag and drop. Once the objects associated with the product are sequenced, the product may be hyper published or sequentially published. Details on the use of the HTK are contained in the following paragraphs.

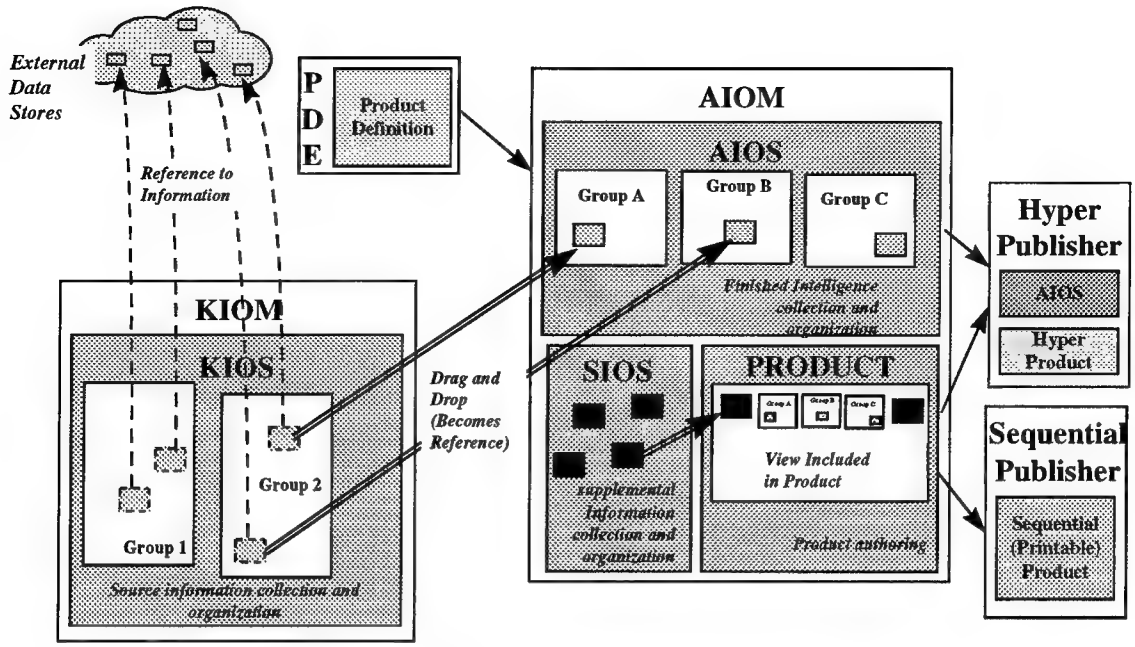

Figure 7.1-1. Hyper ToolKit Logical Concept

(2) An analyst's daily work involves reviewing the information available on the topics they are tracking. There are several sources of information available (e.g., message traffic, corporate datastores, personal datastores, online data services) and several tools available for reviewing data from these sources (e.g., DCARS, InfoDominator, PathFinder). The KIOM provides a tool for storing pieces of information which the analyst believes may become reference material for his assessments. When a piece of information or a group of information may become product reference material, the analyst may import the information into the KIOS using the KIOM. The information collected in the KIOS may be logically grouped based on topic. This concept is identical to the old paradigm.

(3) Figure 7.1-2 shows a case where an analyst is tracking two topics and has therefore organized his KIOS into two groups, "Group 1" and "Group 2", using the KIOM. He has discovered four pieces of information which he believes relevant to assessments he may be asked to make. Two of the pieces of information deal with topic "Group 1" so have been imported, registered, and associated with "Group 1" as information objects 1 and 2. The other two pieces of information deal with topic "Group 2" and therefore have been imported, registered, and associated with "Group 2" as information objects 3 and 4. The objects in the KIOS are maintained as references to the original source material.

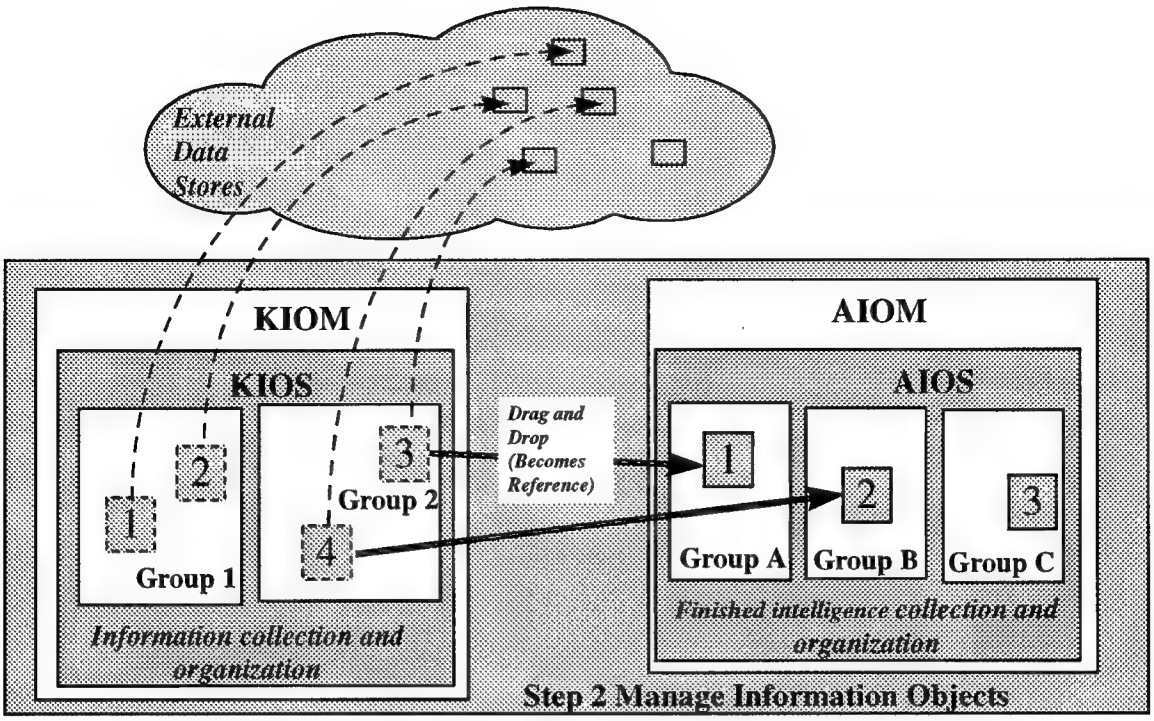

Figure 7.1-2. Information object Management Logical Concept

(4) Eventually the analyst may wish to or be tasked to make an assessment on a particular topic. At this point he may search the collected information in the KIOS on the topic and decide which information is relevant to the assessment to be made. If the assessment is new information, he may create a new information object in the AIOS, otherwise an existing information object may be edited. Information objects may be dragged from the KIOS and dropped on an object in the AIOS. The object from the KIOS is then recorded as a reference for the object in the AIOS. New pieces of information may also be imported directly into the AIOS. This is useful if the analyst locates assessments that he wishes to include in his AIOS. The information objects in the AIOS may be organized into groups based on topic, just as in the KIOS. The new paradigm changes the focus of the work from authoring products to maintaining the AIOS. The AIOS is finished intelligence based on the information in the KIOS.

(5) Figure 7.1-2 shows a case where the analyst has made three assessments by creating information objects in his AIOS. He has decided to group his information objects into three groups in the AIOS, "Group A", "Group B", and "Group C" and has made one assessment for each of these topics. He indicated assessment 1 was derived from information in Object 3 of his KIOS and assessment 2 was derived from information in Object 4 of his KIOS using drag and drop.

(6) Eventually the analyst may wish to or be tasked to author a product based on his assessments. He must create a new product by clicking the **New Product** button on the AIOM toolbar. A product is created and populated with information object from the SIOS and Views from the AIOS. New information objects may be created in the SIOS, and new Views may be created in the AIOS if none are available which fill the need for the product to be authored. Supplementary information objects and Views may then be dragged into the product and ordered. This allows inclusion of Views in a product and is a major difference from the paradigm employed in the first version of the HTK. A product is now a view into the AIOS. Figure 7.1-3 shows that the analyst has decided to use one View from the AIOS and two Supplementary information objects in the product. He has dragged Objects 2 and 4 from the SIOS into the Product Space. He has also added a View from the AIOS to the product. Since the View currently contains three objects, three objects are included in the product. The objects have been sequenced in the desired order by dragging the objects around the Sequential View. The Sequential View may be displayed by the AIOM using graphical icons or a textual list.

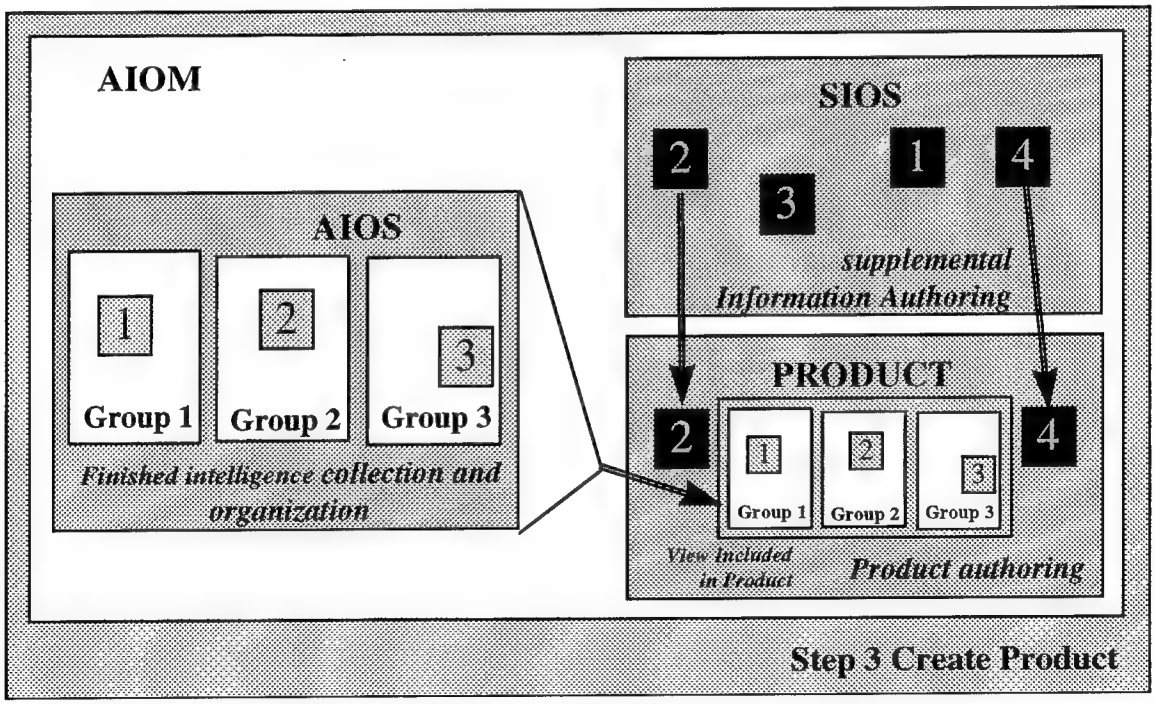

Figure 7.1-3. Product Creation Logical Concept

(7) The ToolKit's Hyper Publisher (HP) transforms the product or AIOS into hyper form that is suitable for online viewing. The HP performs all the tasks required to produce the hyper output from the information objects in the product or AIOS. The hyper publisher performs four steps: (1) convert objects to standard formats (this includes

converting special characters and equations to GIF images for inclusion in the hyper document), (2) generate the Root Information Object (TOC for products, index of objects for an AIOS), (3) generate automatic hyperlinks and convert images to wallet-sized images to be included in the Hyper Product as links to the original images, and (4) generate headers, footers, and title page.

(8) The HTK's Hyper Publisher (HP) transforms both the AIOS and the product into hyper form that is suitable for online viewing. The steps involved in each are similar. While these are shown as discrete steps in the process, the publication of a Hyper Product will check the status of the hyper published AIOS to which it refers. If the hyper published AIOS is out of date (i.e., information objects in the AIOS have been modified since it was last published), the analyst will be given the option to update the hyper published AIOS before the Hyper Product is published.

(9) Figure 7.1-4 shows the steps involved in hyper publishing the AIOS. First the objects in the AIOS are converted to standard formats. Each object is converted appropriately based on its media type and the selected product definition. The standard format for all text-based objects is SGML. Since there may be limitations in the SGML DTD, some additional conversion may be required to capture all the data in the original text-based object. For example, special characters and mathematical equations may need to be replaced with images, if images are supported in the DTD but the font for the special characters is not. Automatic hyperlinking is then performed on the objects in the AIOS. Automatic hyperlink insertion is based on a set of rules associated with the selected product definition. The manual hyperlinks installed by the analyst in the AIOS are maintained in the Hyper Published product. Headers, footers, a title page, and a TOC are not generated for a Hyper Published AIOS. These are all associated with a specific product and are therefore generated only when a Hyper Product is published. Once the analyst has organized the information in his AIOS, he may Hyper Publish the space at the push of a button. This process is new under the new paradigm. It differs from Hyper Publishing of a product in that no headers, footers, title page, or Root Information Object are created.

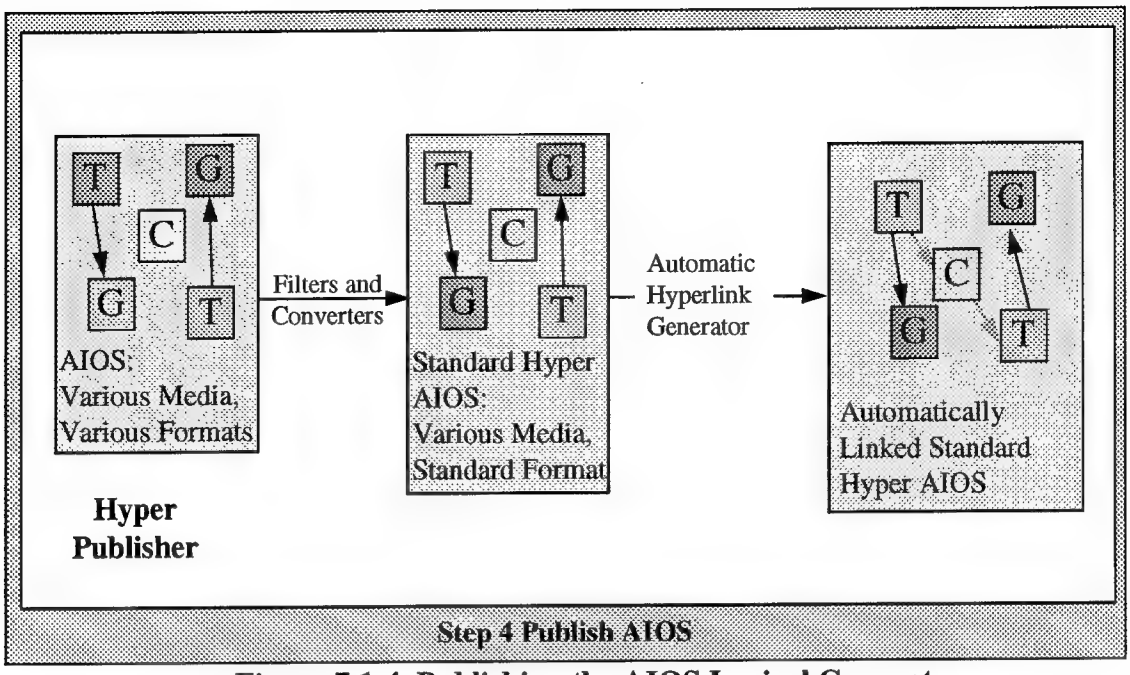

Figure 7.1-4. Publishing the AIOS Logical Concept

(10) Figure 7.1-5 shows the steps involved in hyper publishing a product. First the objects in the product from the SIOS are converted to standard formats. This processing is identical in nature to the conversion process for publishing the AIOS. Next, the Root Information Object is generated. In this case the Root Information Object is the TOC for the product. The TOC is generated based on the sequencing of objects and Views in the product, and on a rule file associated with the selected product definition. Automatic hyperlinking is then performed on the objects in the product, including the Root Information Object. Automatic hyperlink insertion is based on a set of rules associated with the selected product definition. Special characters (e.g., Greek characters) and equations are converted to GIF images to be included in the hyper document. Images are converted to wallet-sized images which are included in the hyper document as links to the originals. Finally, the title page is generated, and the headers and footers are generated and added to the objects in the product. The generation of the title page, headers and footers is based on templates associated with the selected product definition. The generated headers and footers are maintained as templates under the new paradigm. When the product is viewed, the headers and footers are dynamically added to the object in the AIOS based on the product through which the space was entered. Once the analyst has organized the information for the product he may Hyper Publish the product at the push of a button.

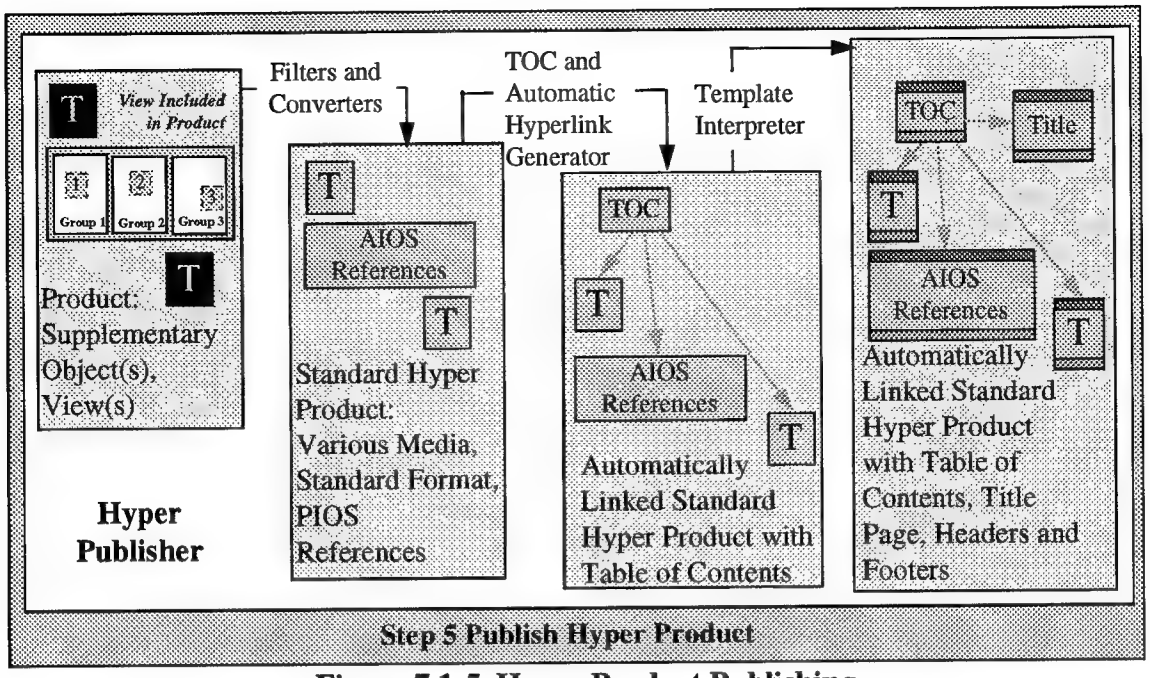

Figure 7.1-5. Hyper Product Publishing

(11) The ToolKit's Sequential Publisher (SP) transforms the product into sequential form. The sequential output is suitable for printing. The SP performs all the tasks required to produce the sequential output from the information objects in the product. There are two steps involved in sequential publishing: (1) convert objects to standard formats and (2) sequence objects.

(12) Figure 7.1-6 shows the steps involved in sequential publishing. First the objects in the product are converted to standard formats. Each object is converted appropriately based on its media type and the selected product definition. Next the objects are sequenced and packaged. The objects are sequenced in the order they occur in the Sequential View of the product Space for the product. They are packaged into a single entity. The packaging may involve concatenating the objects into a single file, or collecting the objects in a FrameMaker Book, for example. Once the analyst has organized the information for the product he may produce the sequential output at the push of a button.

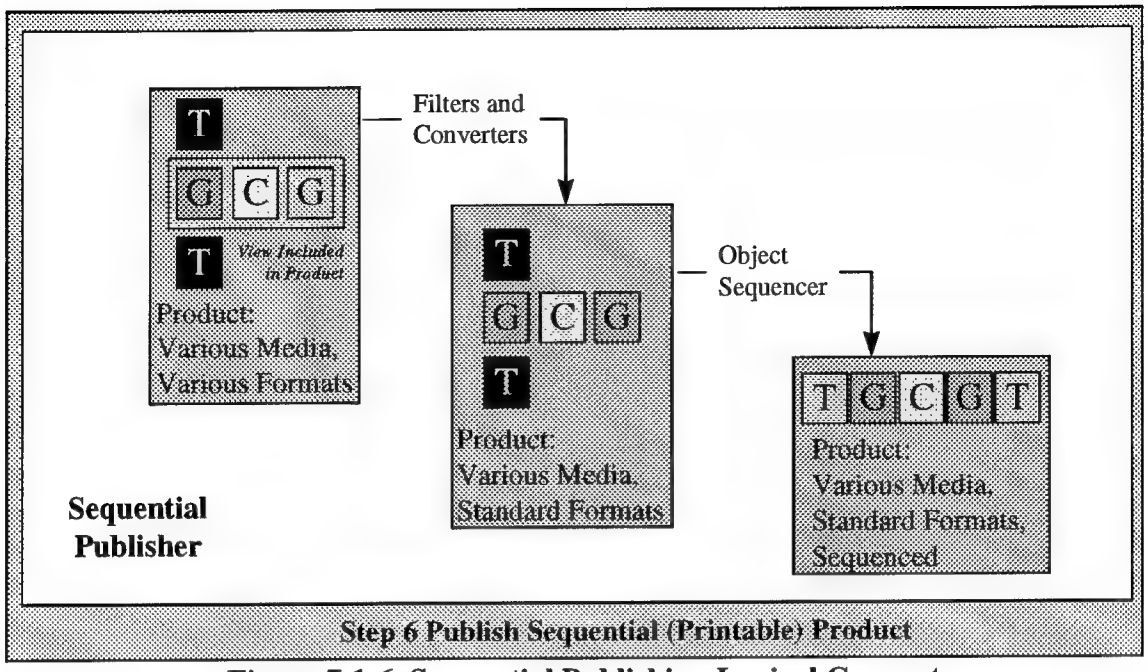

Figure 7.1-6. Sequential Publishing Logical Concept

(13) Using the HTK the analyst concentrates his efforts on discovering, creating, and organizing the information for the product. He then produces the printable sequential version to ship to his customer and the Hyper product to deploy on Intelink at the push of a button.

7.2. Example

(1) Figure 7.2-1 depicts an example of two Hyper Products being authored using the same AIOS. The analyst has three Views of the information objects in his AIOS. View 3 contains all of the Information objects in the space. View 3 is organized first by country. In this example there is only one country, but there could be more. The country group is divided by System. There are two systems for which the analyst has made assessments. Finally the system groups are divided by parts. The analyst has made two assessments on the parts of System 1. The analyst has defined some relationships between the information objects in his AIOS (indicated by the dashed arrows in View 3). View 1 is a view of the systems for Country 1. Notice that the details of the parts for the systems are not included in this View. View 2 is a View of the parts of System 1. The country group is not present in this View. The analyst also has an SIOS which contains four Supplementary information objects to be used in authoring products.

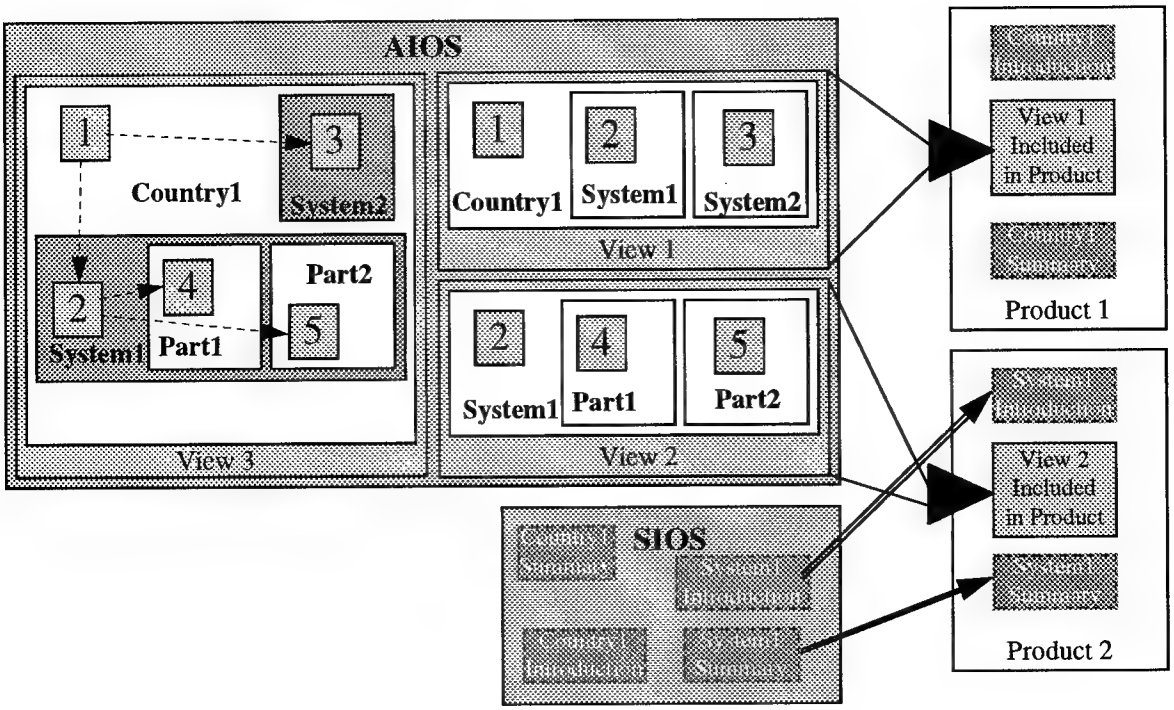

Figure 7.2-1. Hyper Product Authoring Example

(2) Using the Supplementary Information Objects from the SIOS and the Views in the AIOS, the analyst has authored two Hyper Products. Each product has two Supplementary Information Objects and one View. Product 1 is focused on Country 1 and therefore includes View 1, the Country 1 focused View, and two Supplementary Information Objects which discuss Country 1. Product 2 is focused on System 1 and therefore includes View 2, the System 1 focused View, and two Supplementary Information Objects which discuss System 1. The assembling of products is performed using drag and drop from the AIOS and SIOS to the product Space (as indicated by the double-lined arrows). Figure 7.2-2 depicts a user authoring a new product in the HTK using information objects from the AIOS and SIOS, and Views from the AIOS.

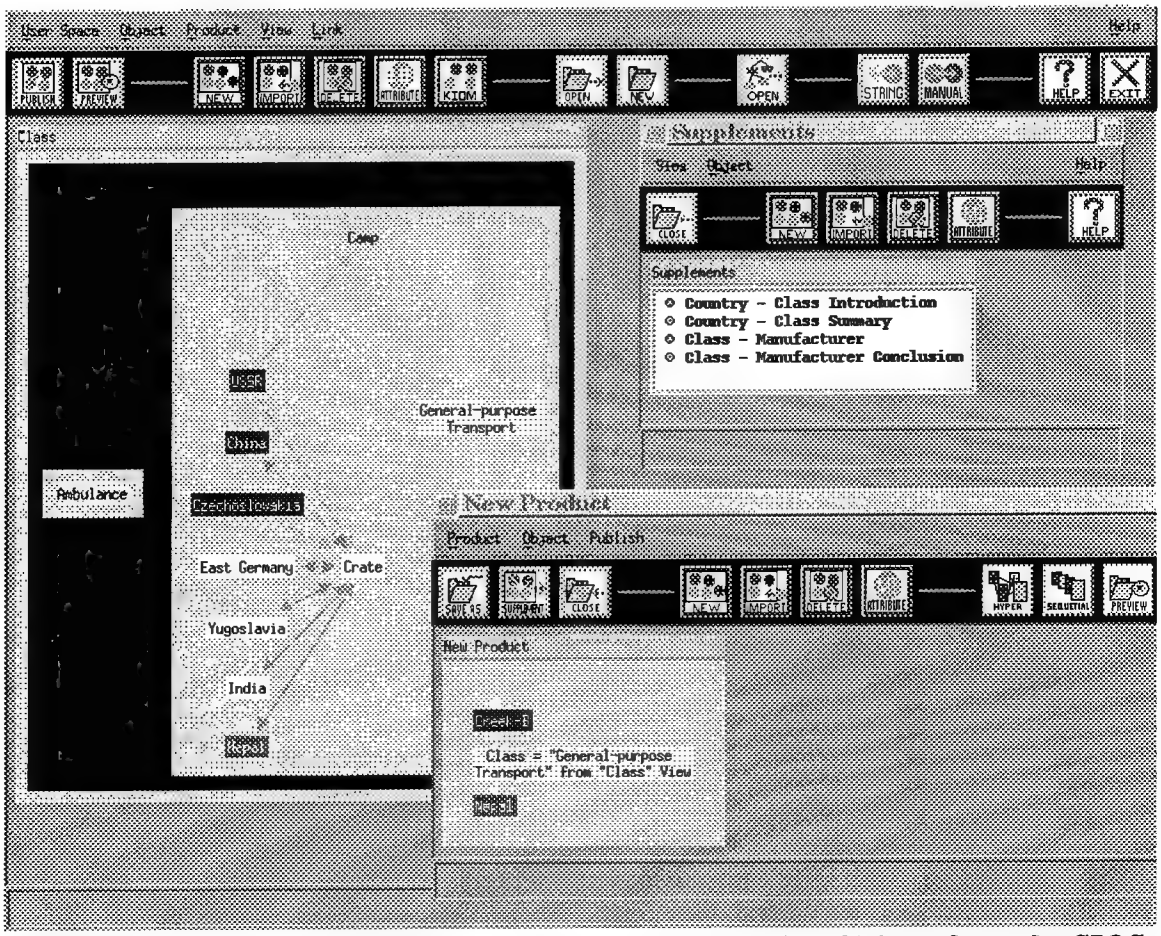

Figure 7.2-2: Authoring a New Product using Information Objects from the SIOS and AIOS, and Views from the AIOS.

(3) Figure 7.2-3 depicts the results of publishing the two Hyper Products authored above. Both products refer to the same published AIOS. The AIOS maintains the links installed by the analyst (i.e., the links shown in View 3 of Figure 7.2-1) when published. Each Hyper Product however gives the customer a different set of paths through the AIOS. The Root Information Object (i.e., TOC) created for the Hyper Product contains a hyperlink to each of the Supplementary Information Objects included in the product and each of the information objects in each of the Views included in the product. Furthermore, the Root Information Objects indicated the sequence of Supplementary Information Objects and Views and the hierarchy of Views. For product 1, the first level header, based on the View included, is Country 1, followed by second level headers System 1 and System 2. For product 2, the first level header, based on the View included, is System 1, followed by second level headers Part 1 and Part 2. At view/read time when an AIOS is entered through a Root Information Object, the headers and footers for the objects in the AIOS are dynamically generated and automatically hyperlinked. Therefore,

the Next Section, Previous Section, and TOC links are correct, based on the organization of the Root Information Object.

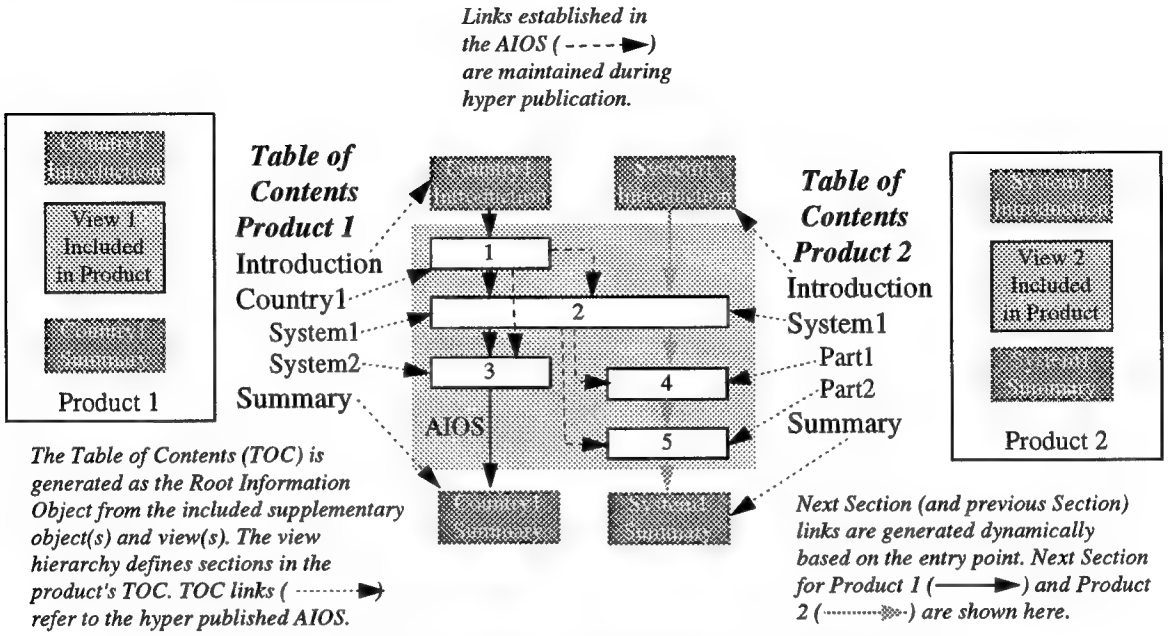

Figure 7.2-3. Hyper Published Product Example

(4) Figure 7.2-4 shows an example of an actual hyper-published product being viewed using the Netscape Navigator online browser. The subject material for the example product consists of information from a 1959 source on aircraft from that era.

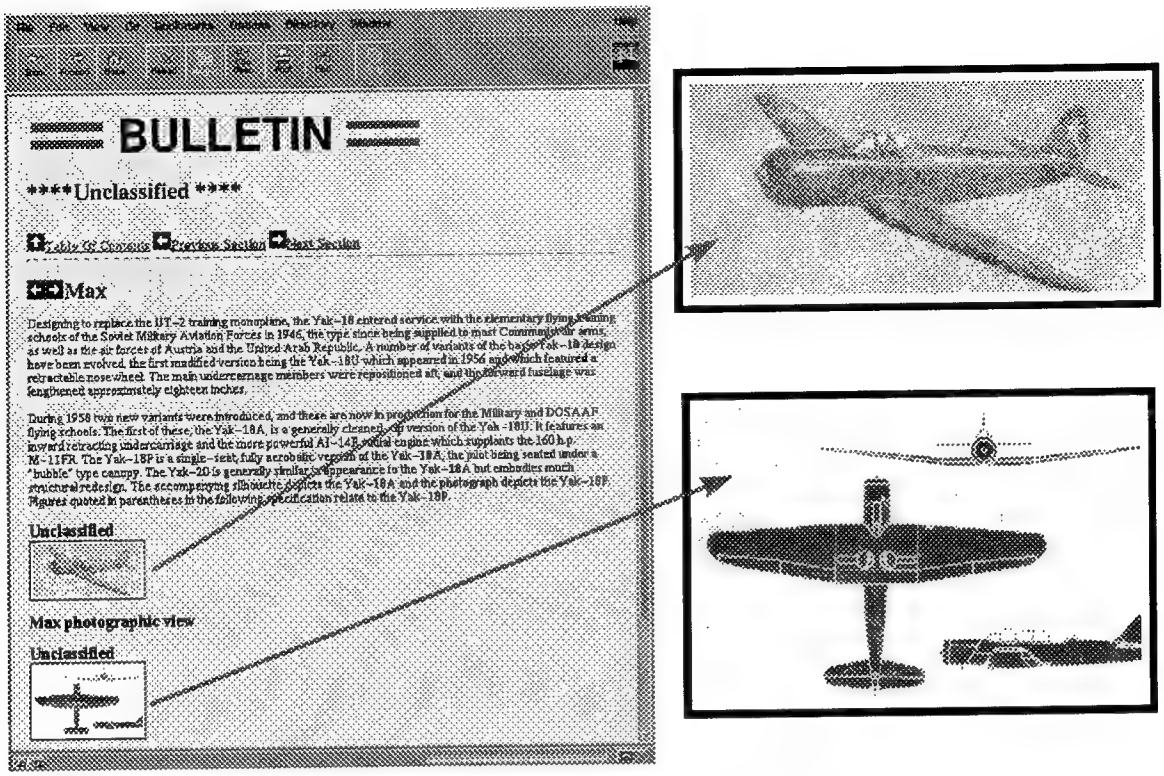

Figure 7.2-4: Viewing a Hyper Published Product Example

8. FUTURE DIRECTIONS

Future directions for the HTK can be broken down into three categories: (1) User Interface, (2) Information Object Management, and (3) Publication (of both products and information spaces).

8.1 User Interface

(1) Managing information objects can be a complex task. Therefore, a more extensive user interface would assist the analyst in organizing and manipulating the information relevant to their needs.

(2) Dealing with a large number of information objects can, at times, be a laborious task. It would be more efficient to be able to perform actions (such as copying or moving) on a group of information objects instead of one at a time. Therefore, it would be helpful to include facilities to manipulate groups of information objects.

(3) There may be occasions when the analyst would like to create individual groups to assist in the organization of objects. Currently, the user interface allows the creation of symmetric Views using existing meta information attributes. A facility for the addition of additional single groups could be provided. For example, adding a group with the attribute "System" and value "Propulsion" under the "Fighter" group (see Figure 8.1-1).

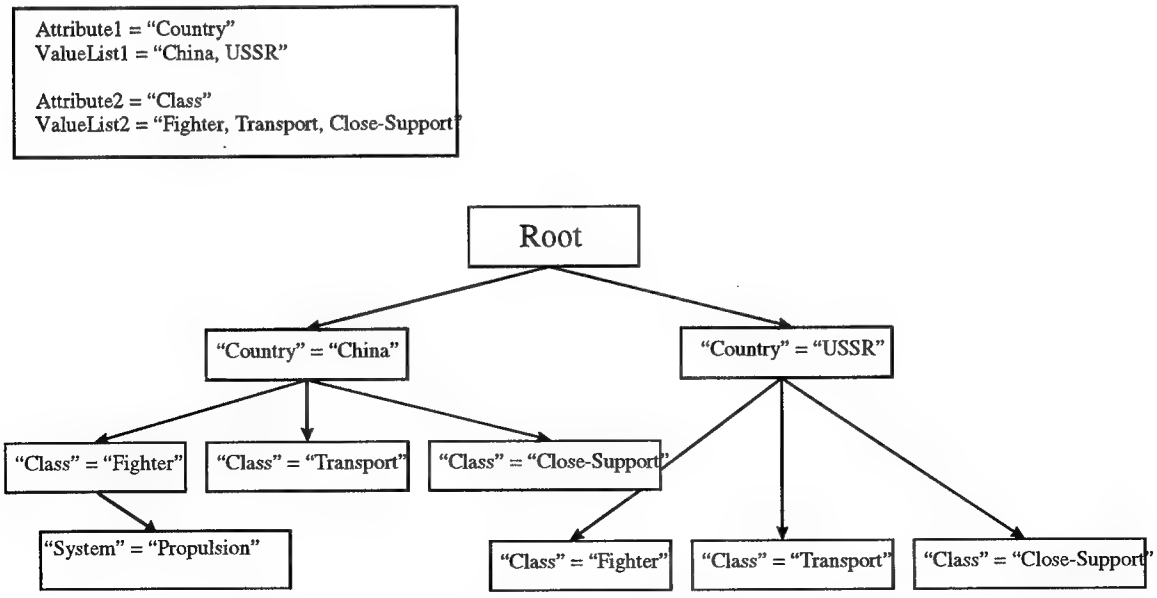

Figure 8.1-1: Adding a single group to a View.

(4) Support for object types needs to be added that will allow the user to define various object types and the meta information tags (attribute names) associated with that object type. When creating new objects, simple selection of the object type automatically includes the necessary meta information tags. Editing an object type to add or delete meta tags automatically does so for all objects of that type. Each type of object should be depicted by a unique, user-chosen color. This color requirement should override the classification color scheme currently in use. A required security classification tag should be included as a default tag for all object types.

8.2 Information Object Manager

(1) As the amount of information maintained by an analyst grows and the relationships between information objects increase in complexity, the IOM must be able to store and manipulate the information objects and the relations between them.

(2) Currently, the IOM allows an information object to *reference* one or more other information objects (see Section 5.1). However, multiple levels of references are not filtered when creating a View Instance. For example, if the object "Colt" references the object "China" as its "Manufacturer" and "China" references "Fresco" as a "Manufactured" object, "Fresco" will not be filtered along with "Colt" and "China" in the View Instance. The IOM should allow the analyst to view multiple levels of references.

8.3 Publication

(1) Publication of both products and information spaces is an extremely important aspect of the HTK, since the overall function of the analyst is to create products and deliver results to intelligence customers. The following HTK enhancements in the publishing area are needed:

- A toolkit extension (TKE) to allow the integration of new media editors and data sources into the HTK. These media editors might include WordPerfect, for example .
- Augment the current publication methods to include embedded applets and new electronic standards.
- Allow hyperlinking in non-text objects. For example, this would allow a map to provide hyperlinks to documents pertaining to individual countries

depending on the location of a mouse click within the graphical image (similar to an image map in HTML).

9. LESSONS LEARNED

(1) The object-oriented paradigm is well suited for the organization, storage, and management of information in various media (in the form of information objects in the HTK), providing support for the representation of the different types of objects of different media and the association of meta information with the information objects.

(2) The object-oriented paradigm is also well suited to the development of Graphical User Interfaces (GUIs) because of the large number of parts (widgets) that are reused.

(3) The targeted users of the AIIS HTK form a diverse group with skills ranging from novice to expert. The user interface to the HTK must be able to accommodate users at both ends of this range. An intuitive, self-explanatory, GUI with an on-line help facility is essential for the novice user, for example, and HTK extension and configuration capabilities should be provided for expert users.

(4) An extensive on-line help facility is an extremely important aspect of a toolkit that will be utilized by a diverse user community. It is likely that many users will not have a hardcopy user manual and must be able to access information describing the toolkit functionality from on-line sources.

(5) The API for Frame Maker Version 5 is only available for the Solaris 2.x operating system, not SunOS 4.x.x. This has hampered the port of the publication facilities, which are a part of AIIS, to machines running Solaris 2.x.

(6) The Hyper ToolKit supports simple relationships between objects in the Information Object Spaces (such as complete inclusion) but needs to support intersection as well. For example, if Country *C* manufactures System *S* and System *S* includes Radar *R*, Country *C* does not necessarily manufacture Radar *R* as well.

10. SUMMARY

(1) This AIIS Hyper ToolKit program has been completed and the AIIS HTK has been delivered to NAIC. The software provides the capabilities described in this report. Highlights include:

Hyper ToolKit Features:

- Graphical user interface (GUI)
    - Iconic direct manipulation
    - Drag and drop
    - Menus, button bars, dialogs
- Document-focused
- Object-oriented
- Extensible
- Configurable
- Supports collaboration

Information Object Manager:

- Information object management
- Import from external data stores
- Meta-data
    - Automated management support
    - Dynamically created user-defined object attributes and attribute values
- User-defined groups and views

Product Definition Component:

- Create, select, modify document type definition
- Create, select, modify templates
- Create, select, modify hyperlinking rule set

Automatic Hyperlink Generator:

- Automatic hyperlink insertion, both intra- and inter-product
- User-defined rules for link generation
- Two types of links: structure-based and string-based

Hyper Publisher:

- Automatic rule-based publishing process
- Automatic media format conversion
- Automatic creation and insertion of "wallet-sized" or "thumbnail" images linked to full-sized images
- Automatic insertion of special icons, labels, headers

- Automatic Table of Contents generation
- Automatic conversion of special characters
- Support for multiple formats per media

Media Supported:
- SGML/HTML/other text types
- Graphics/diagrams
- Tables/spreadsheets
- Images/photos
- Audio/video
- Animation
- Dynamically executed programs

Product/Space Manager:
- Hyper-document (product) management
- Information space management
- Automated authoring support for both
    - electronic hyper documents/spaces
    - hardcopy documents
- Import from IOM
- Collect information objects
- Create, select, edit information objects
- Organize and structure products and information spaces
- Point & click hyperlink insertion
- Publish online electronic hyper-documents at the push of a button
- Publish online electronic information spaces at the push of a button
- Publish hardcopy documents at the push of a button
- Publish both hyper-document & hardcopy from a single document representation

Viewer/Browser:
- View/online electronic hyper-documents
- Traverse/navigate hyperlinks
- Mosaic/Netscape viewing and browsing

Paper Publisher:
- Automatic publishing process
- Automatic insertion of separate media objects
- Automatic media format conversion
- Automatic numbering across textual objects from different editors/word processors
- Automatic Table of Contents generation
- Support for multiple formats per media

11. REFERENCED DOCUMENTS

(1) The following documents are relevant to this Final Technical Report:

System Specification (SSS) for the Advanced Intelligence Information System (AIIS) Hyper ToolKit (HTK) V2.0, Calspan Document Number 8214-09.

System Design Document (SSDD) for the Advanced Intelligence Information system (AIIS) Hyper ToolKit (HTK) V2.0, Calspan Document Number 8214-10.

Software Requirements Specification (SRS) for the Advanced Intelligence Information System (AIIS) Hyper ToolKit (HTK) V2.0, Calspan Document Number 8214-11.

Software Test Plan (STP) for the Developmental Software (DSW_C) of the Advanced Intelligence Information System (AIIS) Hyper ToolKit (HTK) V2.0, Calspan Document Number 8214-12.

Software Test Description (STD) for the Developmental Software (DSW) of the Advanced Intelligence Information System (AIIS) Hyper ToolKit (HTK) V2.0, Calspan Document Number 8214-13.

Software Users Manual (SUM) for the Advanced Intelligence Information System (AIIS) Hyper ToolKit (HTK) V2.0, Calspan Document Number 8214-14

Research and Development Test and Acceptance Demonstration Plan for the Advanced Intelligence Information System (AIIS) Hyper ToolKit (HTK) V2.0, Calspan Document Number 8214-15

(2) Copies of Calspan documents can be obtained by authorized individuals from Calspan Corporation in accordance with the distribution statement on the cover of each document.

12. NOTES

12.1 Acronyms and Abbreviations

AHG	Automatic Hyperlink Generator
AHG_FT	Automatic Hyperlink Generator Functional Test
AIIS	Advanced Intelligence Information System
AIOS	Assessed Information Object Space
API	Application Programmers Interface Capability
API_FT	Application Programmers Interface Capability Functional Test
CDRL	Contract Data Requirements List
CSCI	Computer Software Configuration Item
CSCI_ECSCI_IT	CSCI External CSCI Interface Test
CSCI_ES_IT	CSCI External System Interface Test
DSW_C	Developmental Software Capability
FC	Filters and Converters
FC_FT	Filters and Converters Functional Test
FQT	Formal Qualification Test
HP	Hyper Publisher
HP_FT	Hyper Publisher Capability Functional Test
HTK	Hyper ToolKit
IOM	Information Object Manager
IOM_FT	Information Object Manager Functional Test
IOS	Information Object Space
KIOS	Knowledge Information Object Space
MHG	Manual Hyperlink Generator
MHG_FT	Manual Hyperlink Generator Functional Test
MIM	Meta Information Manager
MIM_FT	Meta Information Manager Functional Test
NAIC	National Air Intelligence Center
OH	Online Help Capability
OH_FT	Online Help Capability Functional Test
OTS	Off the Shelf

P.O.	Post Office
PDE	Product Definition Editor
PFP	Product Fabrication Process
PM	Product Manager
PM_FT	Product Manager Functional Test
RL	Rome Laboratory
SGML	Standard Generalized Markup Language
SIOS	Supplemental Information Object Space
SP_C	Sequential Publisher Capability
SP_FT	Sequential Publisher Capability Functional Test
SRL	Systems Research Laboratory
SRS	Software Requirements Specification
SSDD	System/Segment Design Document
SSS	System/Segment Specification
STD	Software Test Description
STP	Software Test Plan
SYSTEM_T	System Test
TKE	ToolKit Extension
TKE_FT	ToolKit Extension Functional Test
UI	User Interface
UI_FT	User Interface Functional Test
VB	Viewer/Browser

*U.S. GOVERNMENT PRINTING OFFICE: 1998-610-130-61149

MISSION OF ROME LABORATORY

Mission. The mission of Rome Laboratory is to advance the science and technologies of command, control, communications and intelligence and to transition them into systems to meet customer needs. To achieve this, Rome Lab:

a. Conducts vigorous research, development and test programs in all applicable technologies;

b. Transitions technology to current and future systems to improve operational capability, readiness, and supportability;

c. Provides a full range of technical support to Air Force Material Command product centers and other Air Force organizations;

d. Promotes transfer of technology to the private sector;

e. Maintains leading edge technological expertise in the areas of surveillance, communications, command and control, intelligence, reliability science, electro-magnetic technology, photonics, signal processing, and computational science.

The thrust areas of technical competence include: Surveillance, Communications, Command and Control, Intelligence, Signal Processing, Computer Science and Technology, Electromagnetic Technology, Photonics and Reliability Sciences.